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Homo divinus: The ape that bears God's image

Some Christians believe that to allow room for God they must disallow room for evolution. However, aspects of the evolutionary paradigm have been established conclusively, and can be adduced to demonstrate the complementarity that exists between scientific and theological views of the world. Randomly formed, unique genetic markers shared by similar species establish that these species are descendents of a common ancestor in which the unique markers arose. Three features that demonstrate the common ancestry of humans and other higher primates are discussed. The chromosome set of one species can be rearranged into those of other species by cutting and pasting chromosomes, reflecting familiar genetic processes. The presence of unique non-functional gene relics (pseudogenes), and of unique packets of genetic information known as retrotransposons (both of which we share with other primate species) represent genetic markers which can have arisen only once, in a common ancestor. This compelling genetic evidence must inform our understanding of what it means for God to create, of the place of chance in the creative work of God, and of the nature of humanity. It illustrates the way in which God works, and demonstrates his grace as seen in creation and redemption.

Debate over the evolutionary paradigms of science continues to divide the church and distract it from its essential commission. This task is to serve God in society and the world, making known the good news of reconciliation through Christ. The scientific ideas debated in these controversies extend over the range of natural

science. To many people, the issues seem irresolvable. By their very nature, the artifacts of a remote past seem unable to provide straightforward interpretations that could satisfy the skeptics and allow Christians unitedly to address more substantial matters.

Is there no truly tractable issue, in which some aspect of evolutionary science could be demonstrated beyond reasonable doubt, and so illuminate authentically biblical faith? Of course, to the confirmed sophist, no demonstrations carry any weight if they threaten to overthrow cherished *a priori* commitments. But it is hoped that people who are motivated by a 'love that comes from a pure heart, a clear conscience, and a genuine faith' (1Tim.1:5; GNB) could sustain a search for truth, even if they are anxious by what they may find.

With the advance of the exact science of human genetics, one such key issue presents itself. Christians hold to the biblical assertion that people are created by God in his own image (Gen.1:26-27; 9:6; James 3:9). This status ascribed to humanity is a non-negotiable basis of the biblical world-view. ***Theologically*** we are creatures who share vital characteristics with God. But it is now clear that we must hold this conviction together with the sure knowledge that we are an evolved species. This knowledge arises from recent genetic advance, which has established conclusively that we are closely related to the (other) great apes, with which we share many unambiguous genetic markers.[1] ***Biologically***, we are apes. Hence the title of this paper.[2]

The establishment of this test case should dispel the basis of all theologically-motivated conflict over evolution. It will allow our exegetes to approach the Scriptures afresh, knowing that the plain meaning of the biblical narratives cannot include physical anthropology. We are free to learn what they teach us about God's

purposes for his creatures, and the basis of the relation between God and humanity.[3]

Two striking facts present themselves when we compare ourselves with the chimpanzees. The first fact is our extraordinary similarity to them. The other is our vast difference from them. The Bible points to this polarity in our nature by teaching that we are made in the image of God and formed of the dust of the earth (Gen.2:7). This indicates our utter dependence on God:

> …the LORD has compassion on those that fear him;
>
> …he remembers that we are dust (Psa. 103:13; 90:3; cf. 104:29).

That we are 'made of earth', 'came from the earth', 'belong to the earth' and 'are like the one who was made of earth' (1Cor. 15:47-48) stresses our creatureliness, our membership of a fallen race, and our mortality.

1. The fact of our evolution

We share the carbon-based biochemistry of every known life form. We are vertebrates, because we have backbones. We are eutherian mammals, because we are warm-blooded, have hair, are nourished by a placenta during embryonic development and feed on mothers' milk. We are primates, because we have close affinities with the monkeys. And we are numbered among the great apes. In particular the chimps and gorillas share our genetic information to a remarkable extent.[4]

The order of relatedness of humans to the other great ape species has been established by comparing the nucleotide sequences of mitochondrial[5] and nuclear[6] DNA (see Glossary at the end of the article for explanations of technical terms). Human and chimpanzee sequences are 98-99% identical for nuclear DNA (>98.3% for non-coding and ~99.5% for coding DNA). At most genetic loci, we are most

closely related to chimps, but at some loci, chimps and gorillas are the closest.[7] A high degree of genetic similarity implies close relatedness, which in turn implies descent from a common ancestor. Evidence establishing such biological roots will be summarised under three headings. (1) Our chromosomes have taken shape by familiar processes of cutting and pasting. (2) We share with other species uniquely rearranged genes. (3) We share with other species unique random additions to our DNA.

1.1 Cutting and pasting chromosomes

Chromosome structure is studied in the science of ***cytogenetics***. Humans possess 24 different chromosomes, including 22 autosomes (the same for females and males) and 2 sex (X and Y) chromosomes. Closely related species have similarly structured chromosomes. The chromosome sets of the great apes including humans look strikingly similar.[8]

The main difference in the chromosome sets of humans compared to the other great apes is that our chromosome number 2 is an end-to-end (***telomere***-to-***telomere***) fusion of two chromosomes which are separate in all the other great apes. Telomeres are the extreme ends of chromosomes and consist of a highly repeated sequence, $(TTAGGG)_n$. Near the middle of the human chromosome 2 (at band 2q13) is the site where the ancestral ape chromosomes fused. Two telomeric sequences are arranged head-to-head at this site.[9] Adjacent ***sub-telomeric*** sequences are the same as those of the corresponding ape chromosomes.[10] The genetic content of human chromosome 2 is co-linear with that of the two great ape chromosomes from which it is derived.[11] At band 2q21 lie the remains of the redundant centromere of one of the ancestral chromosomes.[12] Such ***telomeric fusions*** are familiar phenomena, arising by naturally occurring mechanisms (Figure 1).

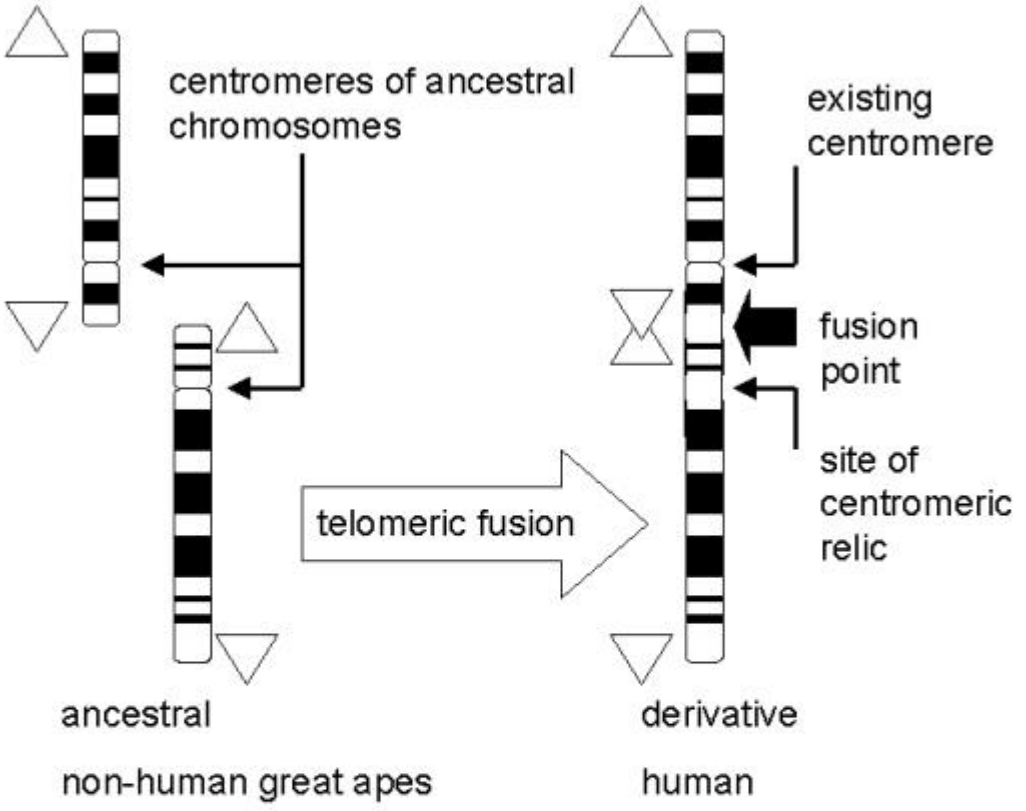

Figure 1: Origin of human chromosome 2 from two precursors (retained in the non-human great apes). The triangles represent telomeres, and depict the head-to-head telomeric arrays at the fusion point.

Humans and chimpanzees also differ by rearrangements ***within*** chromosomes. In these ***inversions***, a chromosome breaks in two places, the intervening segment is flipped 180°, and the bits are joined again. An inversion distinguishing human chromosome 17 from the chimp equivalent has been characterised at nucleotide resolution. Sequencing of the breakpoints has shown that the human chromosome

retains the ancestral form, and the chimp equivalent is derivative.[13] Work on the breakpoints that distinguish human chromosomes 4 and 12 from their chimpanzee counterparts is in progress.[14]

High resolution cytogenetic mapping has shown how the chromosomes of the great apes (humans, chimps, gorillas, orangutans) may be rearranged to form an ancestral set. The structures of most of the chromosomes belonging to this common ancestor have been unambiguously derived.[15] Blocks of human chromosomal material can be cut-and-pasted to give the chromosome sets of gibbons (lesser apes), macaques (Old World Monkeys)[15, 16], or ancestral primates.[17]

There is one exception to the conservation of chromosome structure. The Y (male-determining) chromosomes are extensively remodelled.[18] Such shuffling arises during meiosis because Y chromosomes lack a partner with which to undergo side-by-side pairing (which suppresses rearrangement). Some of these rearrangements have been characterised. Humans, alone of the great apes, possess a segment of the X chromosome that has been copied (***transposed***) into the Y chromosome. A part of this introduced DNA was subsequently flipped (inverted) into a distant site.[19] A section of chromosome 1 has been copied into the Y chromosome of humans and the two chimpanzee species, indicating that humans and chimps are descended from a common ancestor in which the shared trait arose.[20]

Such copied segments of DNA constitute ~5% of the human genome.[21] Humans and chimpanzees (but not other primates) share duplicated chromosomal segments which have generated two copies of a novel gene,[22] and produced the unstable 'CMT' genetic region involved in neurological diseases.[23] These duplications must have been generated in a creature ancestral to humans and chimps.

Another duplication inherited by humans, chimps, and gorillas is implicated in chromosomal instability giving rise to leukaemias.[24]

1.2 Gene decay

Our genome contains 6,000 to 10,000 derelict genes or gene fragments (***pseudogenes***) that no longer produce functional proteins[25] (Figure 2). Some are disabled versions of genes which remain functional in other species. Others are inactive copies or duplicated fragments of functional genes. Each pseudogene is unique. It is the product of a random, unrepeatable originating event (or series of events) that occurred during the history from which humanity arose. Pseudogenes therefore provide unambiguous evidence for the animal ancestry of humans.

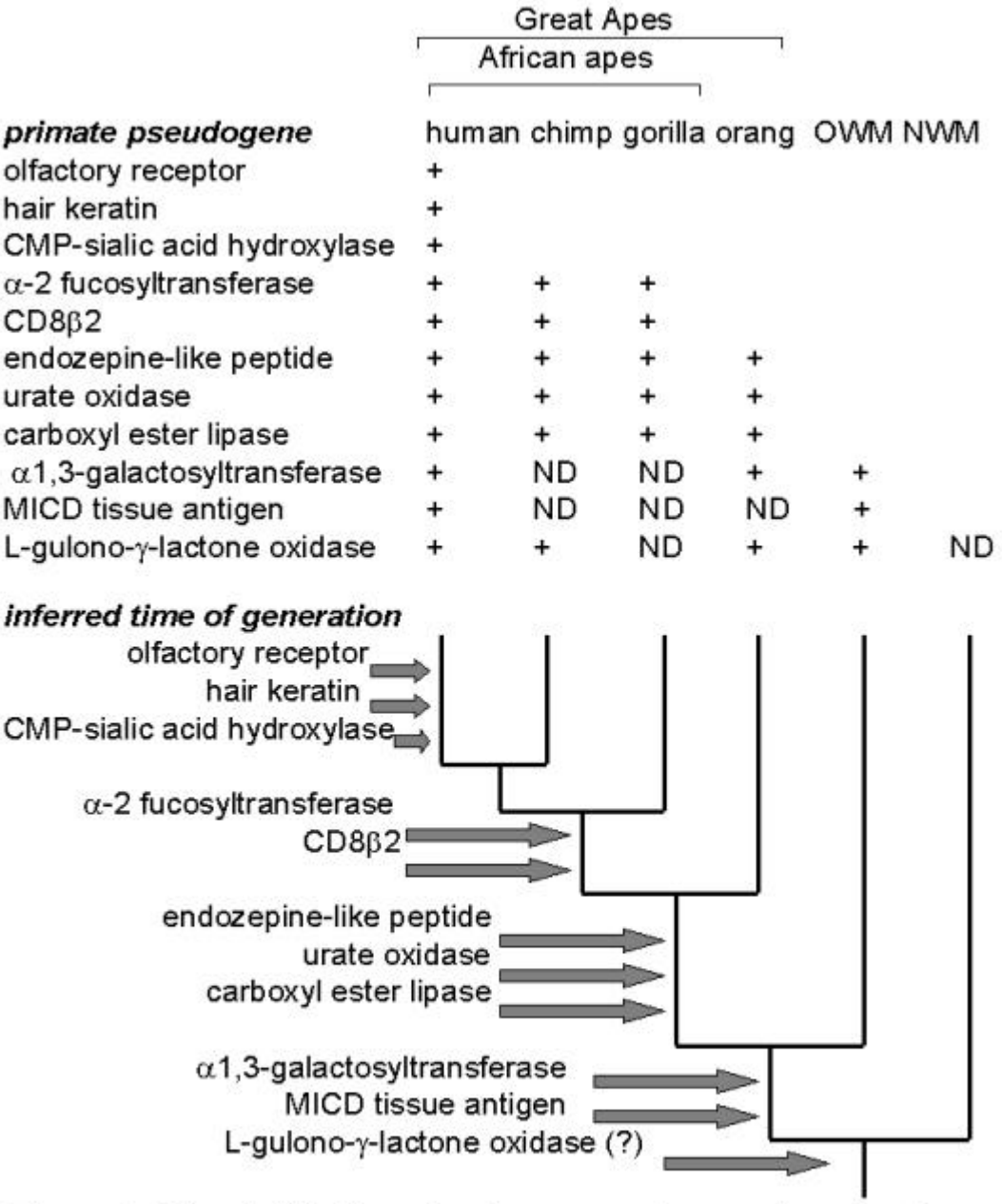

Figure 2: The distribution of unique pseudogenes in primates, and the inferred time at which they were generated during primate history. +: pseudogene present; ND: studies not done OWM: Old World Monkey; NWM: New World Monkey

Some genes are inactivated in humans only. The olfactory receptor (OR) gene family comprises 1000 members. The proportion of OR genes that are pseudogenes is very high in humans compared to other primates.[26] It seems that humans (like dolphins, in which all sampled OR genes are pseudogenes[27]) no longer require an acute sense of smell. One of the OR pseudogenes that humans have inherited has been

shown to be disabled by the mutation of a glutamic acid residue ('E') to an inactivating stop signal ('*').[28]

chimp, gorilla, orang, gibbon	MANENYTKVTEFIFTGLNYN…
human	MANENYTKVT*FIFTGLNYN…

Other genes which are disabled only in humans encode a structural protein[29] and an enzyme.[30]

Some of these genetic fossils are found in humans and other species, and contain the same inactivating lesions in the different species. It is vanishingly unlikely that they would arise independently in two or more species. All the species that possess a particular genetic relic must have inherited it from a common ancestor in which the gene sustained its unique inactivating damage.

For example, the α-fucosyltransferase pseudogene is shared by humans, chimps, and gorillas[31]. A nucleotide triplet CAA (which specifies glutamine, 'Q') has mutated to TAA (a 'stop' signal, '*'):

gibbon, orang	…SPFDVVFRPQAAFLPEWVG…
human, chimp, gorilla	…SPFNVVFRP*

As a result of the mutation to a stop signal, the gene no longer encodes the complete α-fucosyltransferase enzyme. In a further example, humans, chimps, gorillas and orangutans have inherited the same scrambled endozepine-like peptide gene.[32] This gene was destroyed in a great ape ancestor when an 'A' was inserted into the genetic sequence, obliterating the downstream protein sequence ('xxxxx').

macaque	…ALKQLKGPVSDPEKLLIYG…
chimp, gorilla, orang	…ALKQLKGTVCDQEKxxxxx…
human	…ALKQLKGTVCDQERxxxxx…

The urate oxidase gene was also inactivated in a great ape ancestor when a C to T (italicised) mutation generated a 'TGA' ('stop') signal (underlined).[33]

four monkey species	...ATTCAGCGAGATGGAAAATAT...
human, chimp, gorilla, orang	...ATTCAG***T***GAGATGGAAAATAT...

The apes and Old World Monkeys (OWMs) derive from a common ancestor, as they share unique pseudogenes such as those for α-1,3-galactosyltransferase[34] and the tissue antigen MICD.[35] Most primates lack the enzyme L-gulono-γ-lactone oxidase, which is required for the biosynthesis of ascorbic acid (vitamin C). Humans share with other apes and OWMs a relic of the gene for this enzyme, containing a common inactivating mutation (loss of an 'A').[36]

rat	...TCACCCGAGGCGATGACA...
macaque	...TCACCCA_AGCGATGACA...
orang	...TCACCCA_GACGATGACA...
human, chimp	...TCACCTG_GACGATGACA...

Some pseudogenes are uniquely structured ***copies*** of active genes. Such deranged genes can have arisen only once, and yet we share many such scrambled genes with other primates. Mitochondria (the cellular power stations) possess a tiny chromosome, over 600 fragments of which have been copied into the human (nuclear) genome.[37] The events generating each shared pseudogene must have occurred in a creature ancestral to all the existing species that possess it.

species sharing a particular pseudogene	***pseudogene copied from***
human, chimp, gorilla	CD8β-chain-2 gene[38]
human, chimp, gorilla, orang	carboxyl ester lipase gene[39]
human, chimp, gorilla. orang, gibbon	mitochondrial D loop[40]
human, chimp, gorilla, orang, [gibbon], OWM	mitochondrial 16S rDNA[41] and cytochrome b genes[42]

1.3 Random events: accumulation of DNA

DNA is copied ("transcribed") into RNA, which functions during protein synthesis. Rarely, RNA can be copied back into DNA ("reverse transcribed") by enzymes called ***reverse transcriptases***, which are produced by virus-like genetic

entities that exist within cells (Figure 3). Reverse transcribed DNA can be inserted into chromosomal DNA. Each insertion event is random and creates a unique structure, which typically includes short duplications flanking the insert.

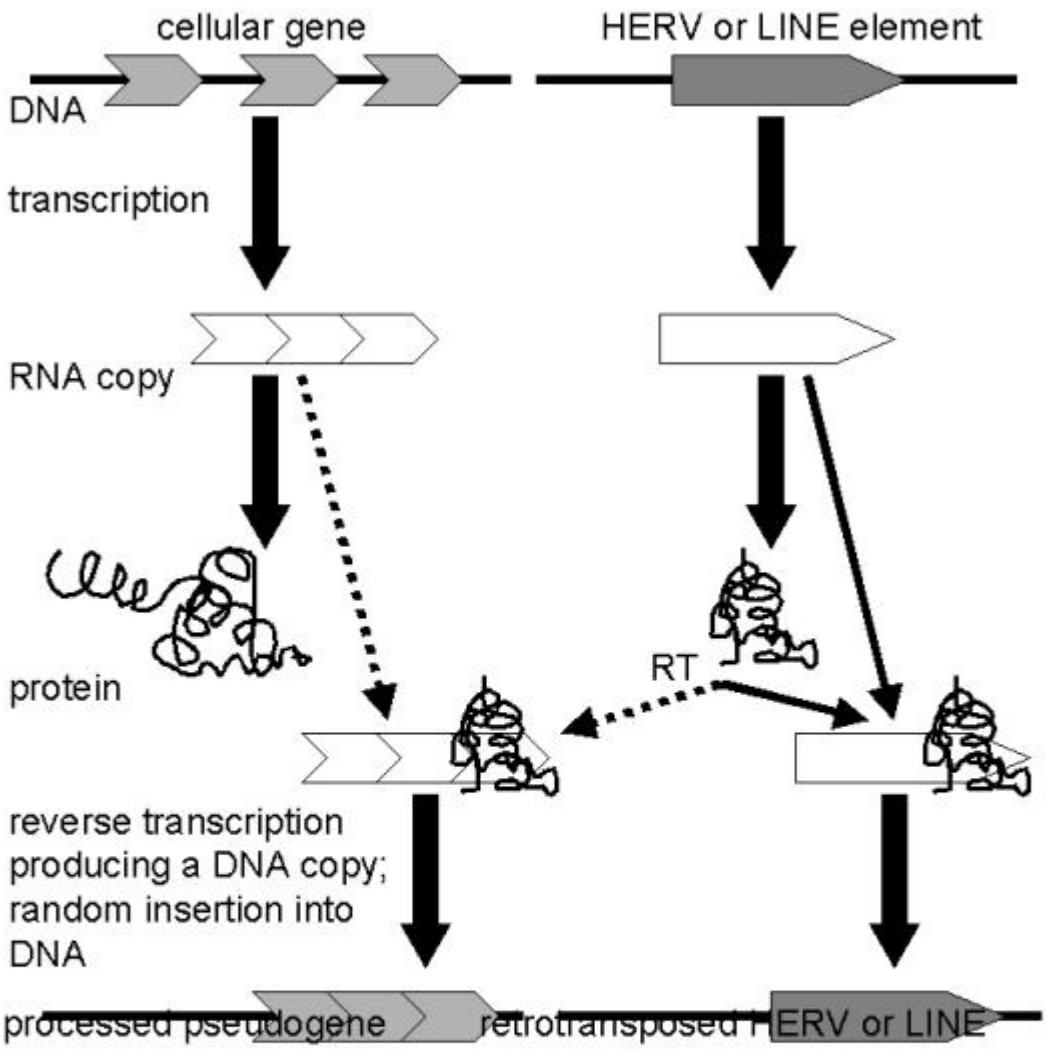

Figure 3. Flow of information in cells. ***Left***: normal flow from DNA (shaded symbols) to RNA (open symbols) to protein. ***Right***: HERV or LINE replication by reverse transcribing their RNA back into DNA. ***Centre***: generation of processed pseudogenes from cellular RNA using HERV or LINE reverse transcriptase (RT).SINEs such as *Alu* sequences are also replicated in this manner.
HERV: Human endogenous retroviruses; LINE/SINE Long/Short interspersed nuclear elements.

These reverse transcribed cassettes occasionally become integrated into the DNA of the germline. They are then transmitted to future generations, providing

unambiguous markers of genetic history. Over 40% of our DNA consists of cassettes of genetic material that have been reverse transcribed and spliced into chromosomal DNA. This parasitic DNA includes human endogenous retroviruses (HERVs), long and short interspersed nuclear elements (LINEs, SINEs), and processed pseudogenes.[43]

Repetitive element	***no. in the genome***	***proportion of genome, %***
HERVs and related elements	300,000	8
LINEs, total	1,400,000	19
LINE, L1 family	500,000	17
SINEs, total	1,800,000	13
SINE, *Alu* family	1,100,000	11
processed pseudogenes	10,000	<1

Reverse transcribed elements such as LINEs, SINES and processed pseudogenes are intracellular parasites that replicate within a single lineage of cells and are severely restricted in their ability to travel into the DNA of other species. Patterns of inheritance are not obscured by transmission as infectious agents. If one of these elements is inserted at the same site in the DNA of different species, then those species must have inherited that insert from the same ancestor. All the species containing the particular cassette are descendants of the one creature in which the unique insertion event occurred.

Our genome is a graveyard of inherited ***HERVs.***[44] Several years ago, evidence was presented suggesting that each of several endogenous retroviruses in human and chimp DNA was the product of the same insertion event.[45] It is now clearly established that humans and other primates possess common retroviruses.[46] In a seminal study, three HERVs were localized to unique sites common to the African great apes, and three to the OWMs (including the great apes).[47]

Many proviruses of the HERV-K[48] and HERV-H[49] families in primate

genomes have been identified, and the distribution of individual proviruses in different species defined:

	number of proviruses	
species sharing a particular provirus	***HERV-K***	***HERV-H***
human	13	
human, chimp	1	
human, chimp, gorilla	10	3
human, chimp, gorilla, orang	7	2
human, chimp, gorilla, orang, gibbon	4	

Representative insertion sites are shown in Table 1. Each unique provirus present in different species establishes that those species are descended from the ancestor in which the provirus spliced itself into the primate genome.

Other unique HERV structures include a HERV-H inserted into a HERV-K provirus (in the African great apes[50]); a cellular gene (*FAM8A1*) inserted into a HERV-K provirus (in apes and OWMs[51]); and a HERV inserted into a pseudogene (in the great apes[52]). A fusion between a HERV-H and a HERV-E provirus has produced a chimaera, present in multiple copies in human, chimpanzee, and gorilla. The sequences around the junction are shown below for representative copies.[53] Dashes (-) indicate the same nucleotide as that in the top sequence; "Δ" indicates a deletion.

human, several proviruses	CTGCCCCCACCCTAG/TCTTGGTTCCCTGAC
human, provirus 1	---------------/--------A------
chimpanzee, two proviruses	---------------/--ΔΔ-C---------
gorilla, provirus 1	---------------/--------A------
gorilla, provirus 2	---------------/----T----------
representative HERV-H	------T-------- CTC-CCC-GA--C-T
representative HERV-E	ACT-GT--TG-TACA ------------G-

The fusion point ('/ ') is the same in every case. The sequences to the left of this are derived from a HERV-H; those to the right from a HERV-E. These HERVs became juxtaposed at this site in a unique event. All copies of this hybrid are derived from the

original. All species possessing copies of this hybrid are derived from the one creature in which the recombination event happened.

Sometimes most of the proviral DNA can be excised and lost, leaving in place only one of the two end sequences (the 'long terminal repeats', LTRs). Many LTRs are shared between humans and other primates.[54] Representative insertion sites are indicated (Table 1).[55] Each element was formed in one insertion event. Different species acquired it by inheritance.

The random insertion of ***LINEs*** and ***SINEs*** into DNA is usually innocuous, but sometimes damages genes. New insertions appear in human populations with an estimated frequency of one germline insertion per 100 individuals.[56]

Individual LINEs with the features of recent insertions are found in human DNA only. Other LINEs at unique sites which show slightly older characteristics are shared by humans and chimps, or by humans, chimps, and gorillas. Over 50 older LINEs have been identified that are common to the great apes.[57]

The insertion of a SINE (such as an *Alu* cassette) into cellular DNA is rare and random. It is highly unlikely that the same SINE would insert independently into the same site in different species.[58] *Alu* sequences are clear markers of evolutionary relationships.[59] A table depicting the species distribution of individual *Alu* sequences (usually identified by the gene in which they are found) is shown below.

groups with common Alu insert	***Alu location***
great ape	pseudo-autosomal boundary[60]
	α-globin 2 gene[61]
great ape, lesser ape	α-globin genes (six cassettes)[62]
	'EPL' locus[63]
great ape, lesser ape, OWM	*RHAG* genes (three cassettes)[64]
	FRG1 gene (two cassettes)[65]
	interferon-γ gene[66]

	CMT1A-REP locus (two cassettes)[67]
great ape, lesser ape, OWM, NWM	RHCE blood group gene[68]
	blue opsin gene[69]
	BC200 gene[70]
great ape, lesser ape, OWM, NWM, tarsiers	ATP synthase β gene,
	zonadhesion gene,
	α1-microglobulin gene[71]

The insertion site of an *Alu* element common to the apes, OWMs and NWMs is provided as an example.[72] This *Alu* element has resided in primate DNA since the simian common ancestor. The 16 nucleotides shown on each side of the *Alu* cassette represent the duplicated sequences identifying the unique inseretion site.

insertion site	TAATAATACAACTTTT
human	---AG---TG------[Alu]TAATAATACAACTTTT
chimpanzee	---CG----G------[Alu]----------------
gorilla	---CG----G------[Alu]----------------
orangutan	---CG----G------[Alu]-------ΔΔG------
gibbon	---CG----G------[Alu]-Δ--------------
baboon (OWM)	----G---AG------[Alu]----------------
rhesus macaque (OWM)	----G---AG------[Alu]ΔΔΔ------G------
barbary macaque (OWM)	----G---AG------[Alu]ΔΔΔ------G------
marmoset (NWM)	----------------[Alu]--Δ---C----A---C

Alu elements shared between humans and other primates have mediated chromosomal rearrangements.[73] They have been co-opted as gene regulators[74] and have been used to assemble new genes.[75] The strategy of identifying species with common SINE insertions has provided unambiguous evolutionary relationships in various mammalian orders, including primates,[76] whales and dolphins,[77] and ruminants (giraffe, bongo, ox, bison, sheep and goats).[78] How much unnecessary heat has been generated over the question of the giraffe's neck!

Processed pseudogenes arise when RNA arising from normal cellular genes is reverse transcribed (by LINE reverse transcriptase) and stitched back into chromosomal DNA. These genetic fossils typically accumulate mutations and disappear into the genetic background. If a particular processed pseudogene (at a

unique integration site) is found in different species, the single, random integration event which gave rise to it must have occurred in an ancestor of all the species possessing that pseudogene. Many processed pseudogenes are common to humans and other primates.[79] A pseudogene common to humans and rhesus macaques (*Per4*) is itself interrupted by a SINE called a MER-2 element.[80] The serine hydroxymethyltransferase pseudogene has been shown to be common to 20 primate species including tarsiers.[81] A processed version of the phosphoglycerate mutase gene, investigated in humans and chimpanzees and present in species as remote as the macaque, retains its function.[82]

2. Some implications

Arguments about evolution continue after 150 years. But the unique genetic markers reviewed above establish unequivocally the fact of our evolution. DNA markers called microsatellites are used for forensic purposes. They establish guilt or innocence, and resolve questions of paternity beyond reasonable doubt even though they are not unique markers like pseudogenes and retrotransposed sequences.[83] The assertion that we have evolved is established beyond reasonable doubt. These findings must deal to the hermeneutic paradigm of biblical literalism what Galileo's findings dealt to the Aristotelian paradigm of his day. When we surrender the expectation that the Bible teaches physical anthropology, we become free to rediscover its liberating message about the nature of God and his redemptive purposes.

2.1 Creation

The findings of primate genetics illuminate the Bible's theological statements regarding the creative work of God. That God created human beings (Gen.1:27;

Psa.100:3) does not imply instantaneous action. God's creation of humanity encompasses past primate history, the present, and whatever is to come. The sweep of human evolution illustrates how God's work of creation is a continuing relationship of dependence between the world and God;[84] a continuing act of God's will;[85] an eternal covenantal relationship.[86]

This should not surprise us. God is worshiped as the creator of Israel (Isa.43:1,15; 44:2; Psa.149:2), but this does not refer to one or a few discrete events. God created Israel through the entire continuum of Israel's history. In fact, the work continues (Gal.6:16; Eph.2:15), and completion is future (Rom.11:26). Similarly, God is the creator of each individual person (Psa.119:73; 139:13; Eph.2:10; 1Pet.4:19). This creative work cannot be restricted to any event. It encompasses the continuum of our development from fertilisation to ultimate transformation (1Cor.15:42f; Phlp.3:21).

2.2 Chance

Our genetic history is constituted by myriad chance (random, unpredictable, unrepeatable) events, unique milestones that mark stages of our evolutionary past. Is the demonstration that ***chance*** events have formed our genome compatible with the biblical assertion that we are created by God? This issue illuminates the distinction between two broad meanings of 'chance'.[87]

Chance in a physical sense is a technical term used to describe aspects of the behaviour of components of the material world. It analyses the unpredictability of events in parlance appropriate to scientific analysis. Chance in a metaphysical (quasi-religious) sense indicates the absence of design or of personal, causal agency.

Randomness of molecular events (physical chance) bears no necessary connection with a metaphysical presupposition that denies purpose in the universe (metaphysical chance). The randomness of brownian motion is directed into the ordered processes of biochemistry by the energy present in biological molecules. 'The idea of generating order by 'selecting' from random variations is hardly new. It is the fundamental idea of Darwin's theory of natural selection.'[88]

Chance as an aspect of the intelligibility God's creation 'is not an alternative to design but a creative part of it',[89] an aspect of God's creativity.[90] God has ordained random processes as a means of generating novelty. In the interaction between freely-acting, contingent chance and constraining, directing necessity, God has chosen to create the creature which would bear his image.[91] A writer in this journal has said 'order is essential together with chance in the evolution of the universe.' God has created the forces of physics 'with prescient precision'.[92] The fruitful interplay of novelty-generating chance and lawful necessity in the universe evinces divine design. Chance is a part of the anthropic fruitfulness of the universe.

2.3 The status of humanity

Our close genetic similarity to the chimpanzees is an extraordinary concomitant of vast differences in mental capacity. We are connected genetically to primate antecedents. There is intense interest in identifying qualitatively altered genes which (it is stated) 'make us human'.[93] They may have remodelled brain structure,[94] modified brain sugar biochemistry,[95] or conferred the ability to speak.[96] It has been suggested that gene expression patterns in the brain will elucidate the difference between humans and other apes.[97]

Genes are necessary but not sufficient to specify our nature as people. They

describe only the substrate that constitutes our ***potential humanity***. Baltimore has said that the question, 'What makes us human?' cannot be answered by staring at a genome.[98] Another commentator has said that 'to be a human person means more than having a human genome; it means having a narrative identity of one's own'.[99] And Paabo has warned against the

> insidious tendency to look to our genes for most aspects of our 'humanness', and to forget that the genome is but the internal scaffold for our existence. We need to leave behind the view that the genetic history of our species is *the* history par excellence. We must realise that our genes are but one aspect of our history, and that there are many other histories that are even more important.[100]

He concluded that genomics in isolation can never tell us what it means to be human, and invoked the humanities as a further approach that must help define our humanness. He could have specified the events upon which theology reflects (although he did not).

Consideration of our 'exosomatic chromosomes' (culture, stories, and relationships) is required for an understanding of what it means to be human. We need to know other people to progress from an organismic potential humanity to a social ***basic humanity***. The inability of (genetically normal) feral children (who grow up apart from human company) to later become integrated into society is a telling reminder that our basic humanity depends on the intangible and vulnerable requirement that we know other people. This insight is expressed in the Xhosa proverb *Umuntu ngumuntu ngabantu* (a person becomes a person through persons).[101]

Spanner described how western culture has conditioned us to think of life and death as physical states of a thing-in-itself. 'The biblical understanding of life

connects it with knowing - existential knowing. It thus implies entering into relationship - with God, with other persons and, to a lesser extent, with things.' Biblically, life is not a property of the thing-in-isolation, but it 'consists in cognitive and responsive relationships'.[102] Green also has emphasised that the Hebrew Bible does not define the human person in essentialist terms (as a thing-in-itself), but in relational terms. We are 'genuinely human and alive only within the family of humans brought into being by Yahweh, and in relation to the God who gives life-giving breath'.[103]

Messer reflected helpfully in this journal on what it means to be human in the context of genomic science. He has taken his cue from the concept of the triune God, who has no being apart from communion. Therefore for us there can be no personhood prior to interpersonal relationship:

> If relationship or communion is intrinsic to the being of the triune God, then human personhood, made in God's image is also inescapably relational. Human persons are not adequately described as the isolated, autonomous individuals of much modern thought, but are in some sense the products of their social relations.[104]

A third quality that defines humanness is described by the concept of 'the image of God'. It seems that the physical (potential) and social (basic) aspects of our humanity are the necessary substrate in which God's image could be expressed. Prehistorical artefacts have documented the rise of rationality and creativity over vast time scales, but neither faculty expresses the meaning of the divine image.[105] To be God is to be persons in relation; so to image God is to be 'called to a life in relation', 'to be called to a relatedness-in-otherness'; 'to be called to represent God to the creation and the creation to God';[106] to be called 'to a unique role in God's economy';[107] to be called

to work with God to transform the world;[108] to be called to reflect God and make him visible among men.[109] Jeeves has written recently, 'The meaning of the 'image of God' is thus to be found in the human vocation, given and enabled by God, to relate to God as God's partner in covenant, to join in companionship with the human family, and in relation to the whole cosmos in ways that reflect the covenant love of God'.[110]

Possession of the 'image of God' thus refers to the spiritual capacity to relate to God, and the receipt of a commission to serve him.[111] Relation and commission are aspects of 'revelation'. The Bible story of humanity starts with revelation. Prior primate evolution is but the presupposition of humanity's capacity to know and serve its creator and thereby possess his image. In knowing God, we are granted a ***fulfilled humanity***. Gunton connects the three aspects of our existence:

> Who we are is made known to us through the relations in which we stand. There are three forms of relation that can be abstracted from the overall network: relations with the world, with other human persons, and with God.[112]

But human beings have repudiated God's call by which they receive his image. In the New Testament, the words used in Genesis ('image' and 'likeness') were given new content by referring specifically to Christ (rather than humanity) as the image of God. 'He is not only the true image of God but also the source of human renewal in it.'[113] The one who perfectly bears that image becomes the vehicle of the renewal of that image in all who come into relationship with him.

Jesus definitively linked the fullness of life with knowing God: 'And eternal life means knowing you, the only true God, and knowing Jesus Christ whom you sent.' (Jn.17:3; see also 1Jn.5:20) Just as our basic humanity requires knowledge of other people, so fulfilled humanity requires knowledge of God as revealed in Jesus Christ.[113]

The forms of personal knowledge that integrate us into human society and that transform us into the community of God are mediated by stories. By means of the latter,

> we come to see the significance and coherence of our lives as a gift, as something not of our own heroic creation, but as something that must be told to us. … The little story I call my life is given cosmic, eternal significance as it is caught up within God's larger account of history … The significance of our lives is frighteningly contingent on the story of another.[114]

2.4 The scandal of particularity and the grace of God

Our genetic record implies a long history during which often numerically small populations of primates gradually acquired the features of human beings. This seems to illuminate the question of the 'scandal of particularity'. Is it really credible that an obscure peasant carpenter could be the unique revealer of God, the divine redeemer of the world and the consummator of the universe? Is it believable that an insignificant group of tribes-people eking out an existence on the rugged hills of Palestine could be the channel by which God would redeem humankind and transform the world?

Is it feasible that a lineage of ape-like creatures progressively losing its ability to make vitamin C, its hair, and its sense of smell, and sustaining the random invasion of myriad retrotransposons, could be ancestral to *Homo divinus?* Could such inauspicious beginnings precede the creature which would reconstruct its evolutionary past, reflect on its future, and respond to its creator? It is now an empirical fact that our genetic endowment was constructed in a lineage of nondescript apes. God works through apparently insignificant and particular players to achieve unimaginably grand

ends. So it is not incredible that Jesus of Nazareth should be the liberator of humankind, or that the Hebrew people should be the channel of God's dealings with the world.

Our very creation is an act of sheer grace. In an initiative of unconditioned love, God conferred his likeness upon a member of the ape family and brought into being *Homo divinus*, the ape-in-the-image-of-God, with the unique capacity to know, love and serve its creator. There is no room for hubris here. Our biological roots remind us that we are human not because of any inherent or necessary superiority to the rest of the animal kingdom, but in creaturely dependence on God's goodness. The Hebrew poet asked "What are human beings that you [God] think of them?" and then seemed to answer his own question:

> … you made them inferior only to yourself,
>
> you crowned them with glory and honour.
>
> You appointed them rulers over everything you had made (Psa.8:5-6; GNB).

And when in selfishness we perverted every faculty that we were so generously given, God did not have to redeem us, apart from the impulse of his love and holiness. The incarnation of the eternal Son of God as one of us (an ape-in-the-image-of-God) re-established a human being as 'ruler over all things'. His self-sacrifice by which 'through God's grace he should die for everyone' (Heb.2:6-10) extends this same unconditioned grace to ever more stupendous heights.

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HERV	*species*	*insertion site*
K105	human	CTCTGGAATTC[HERV]GAATTCTATGT
	chimpanzee	CTCTGGAATTC[HERV]GAATTCTATGT
	bonobo	CTCTGGAATTC[HERV]GAATTCTATGT
K110	human	GAATCTGAGAC[HERV]TGAGACAATAT
	chimpanzee	GAATCTGAGAC[HERV]TGAGACAATAT
	bonobo	GAATCTGAGAC[HERV]TGAGACAATAT
	gorilla	not determined [HERV]TGAGACAGCAT
	orangutan	GAATCTGAGACAATAT
H/env59	human	AAACAATATT[HERV]ATATTATGTT
	chimpanzee	AAACAATATT[HERV]ATATTATGTT
	gorilla	AAACAATATT[HERV]ATATΔΔΔGTT
	orangutan	AAACAATATT[HERV]ATATTATGTT
	gibbon	AAGGAATATTATGTT
H/env60	human	TCTCCAAATA[HERV]AAATATACTA
	chimpanzee	TCTCCAAATA[HERV]AAATATACTA
	gorilla	TCTCCAAATA[HERV]AAATATACTA
	orangutan	TCTCCAAATA[HERV]AAATATACCA
	gibbon	TCTCCAAATATACTA
H/env62	human	GTTATCCAAC [HERV] CAAACTAAAT
	chimpanzee	GTTATCCAAC [HERV] CAAACTAAAT
	gorilla	GTTATCCAAC [HERV] CCAACTAAAT
	orangutan	GTTATCCAACTAAAT
axin gene	human	CACCCCGG[LTR]CCGGGACG
	chimpanzee	CACCCCGG[LTR]CCGGGACG
	gorilla	CACCCCGG[LTR]CCGGGACG
	orangutan	CACCCCGG[LTR]CCGGGACG
	gibbon	CACCCCGGGACG
U2 snRNA	human	TAGCTGAGATAA[LTR]AGATAAGATATA
	chimp	TAGCCGAGATAA[LTR]AGATAAGATATA
	gorilla	TAGCTGAGATAA[LTR]AGATAAGATATA
	orang	TAGCTGAGATAA[LTR]AGATAAGATATA
	baboon	TAATCGAGATAA[LTR]AGGTAAGATATA

Table1: Insertion sites of HERVs or LTRs in primate DNA[47-49,55]
The nucleotide sequences in which seven endogenous retroviruses have inserted are shown. Underlined nucleotides are short duplications which form at insertion sites. The retroviral element inserted into the DNA of an ancestor of all the species that possess it. In five cases, the original, uninterrupted sites are shown.

Glossary of technical terms

centromere: a constriction in a chromosome, involved in organising chromosomal movement during cell division.

chromosome: a DNA molecule and its associated proteins. When cells divide, the chromosomes condense into compact structures that can be observed microscopically.

DNA: deoxyribonucleic acid, the molecule that encodes and transmits genetic information.

endogenous retrovirus: A genome of the retroviral class transmitted as part of the genome of a host organism.

genome: the total genetic information of an organism.

insertion site: the exact location in a DNA molecule into which genetic elements such as retrotransposed sequences splice themselves.

LINE (long interspersed nuclear element); a segment of DNA that can colonise other sites of the genome using its own reverse transcriptase enzyme.

mitochondria: structures within cells where energy-carrying molecules are generated. They possess a small chromosome of their own

nucleotide: the basic information-carrying unit of DNA or RNA.

processed pseudogene: a copy of a gene that has inserted into DNA via an RNA intermediate.

provirus: the segment of DNA representing a viral genome that has been spliced into cellular DNA

pseudogene: a non-functional derelict gene, generated by damage to, or partial duplication of an authentic gene

retrotransposition: the process by which RNA molecules are reverse transcribed into DNA, and inserted into chromosomal DNA.

reverse transcription: the process by which RNA is copied into DNA by enzymes ('reverse transcriptases') encoded by retroviruses or LINEs.

RNA: ribonucleic acid, copied from DNA, and involved in the synthesis of proteins.

sequence: the order of building blocks in a nucleic acid or a protein. DNA sequences consist of four different units or nucleotides (A, T, G, and C), whereas protein sequences are composed of 20 amino acids (each represented by a letter).

SINE (short interspersed nuclear element): small segments of DNA that can colonise new sites in the genome using a reverse transcriptase molecule derived from a LINE.

telomeres: the sequences at the ends of chromosomal DNA.

transcription: the process by which DNA is copied into RNA.

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86 Van Till, H.J. *The Fourth day* (Grand Rapids: Eerdmans, 1986) 226.

87. as discussed variously by MacKay, D.M., ref. 84, 48f; Forster, R. and Marston, V.P. *Reason and Faith* (Eastbourne: Monarch, 1989) 400f; Alexander, D. *Rebuilding the Matrix* (Oxford: Lion, 2001) 332f.

88 Oster, G. 'Darwin's motors'. *Nature* (2002) 417, 25. Ordered functions emerging from brownian randomness include movement of motors along intracellular rail tracks, protein secretion through membranes, interactions between substrates and catalytic sites, and the F_0F_1 ATPase that generates ATP. In molecular engines, 'brownian motion drives both the power and exhaust strokes'.

89 Forster, R and Marston, V.P., ref.87, 416.

90 Peacocke, A. *God and the New Biology* (London, Melbourne: Dent, 1986) 62,99.

91 see Polkinghorne, J. *The way the World Is* (London: SPCK, 1983) 11-12; *Science and Creation*, 47f; Wright, J. *Designer Universe* (Crowborough: Monarch, 1994) 42.

92 Burge, T. 'What else does physics tell us about God?' (Correspondence). *Science and Christian Belief* (2002) 14, 79.

93 Gibbons, A., ref. 7.

94 Balter, M. 'What made humans modern?' *Science* (2002) 295, 1219.

95 through the inactivation (only in humans) of the CMP-sialic acid hydroxylase gene. In a news report entitled "Sugar separates humans from apes", it was proposed that the loss of this enzyme might make the brain work better. *Science* (2001) 291, 2340. See also ref. 30.

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97 Enard W, Khaitovich P, Klose J *et al*. Intra-and interspecific variation in primate gene expression patterns. *Science* (2002) 296, 340. But is the difference in expression of genes in the human brain a prerequisite or a consequence of human relationality?

98 Baltimore, D. 'Our genome unveiled.' *Nature* (2001) 409, 814.

99 Mauron, S. 'Is the genome the secular equivalent of the soul?' *Science* (2001) 291, 831.

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101 Villa-Vicencio, C. and de Gruchy, J.W. *Doing Ethics in Context* (Cape Town and Johannesburg: David Philip, 1994) 29.

102 Spanner, D. *Biblical Creation and the Theory of Evolution* (Exeter: Paternoster Press, 1987) 71.

103 Green, J.B. 'Eschatology and the nature of humans: a reconsideration of pertinent biblical evidence', *Science and Christian Belief* (2002) 14, 33. Green quotes Polkinghorne to the same effect: "The pattern that is me must include those human relationships that do so much to make me what I am, and also it must express the nature of my unique creaturely relationship with God." (p.39, note 21).

104 Messer, N.G. 'Human genetics and the image of the triune God', *Science and Christian Belief* (2001) 13, 99. Quotations are from pp.103, 105.

105 Gunton, C.E. Christ and Creation (Carlisle: Paternoster Press and Grand Rapids: Eerdmans, 1992) 102, 106, 120-121.

106 *ibid*, 101-102.

107 Osborn, L. *Guardians of Creation* (Leicester: Apollos, 1993) 133.

108 *ibid*, 139.

109 Konig, A. *New and Greater Things: Re-evaluating the Biblical Message on Creation* (Pretoria: UNISA, 1988) 129.

110 Jeeves, M. 'Changing portraits of human nature', *Science and Christian Belief* (2002) 14, 26.

111 Other theologians who juxtapose the *Imago dei* with a divine calling or commission include Ron Sider, in Berry, R.J. (ed.). *The care of Creation* (Leicester: IVP, 2000) 47-48, and Murray Rae, in Mann, L.R.B. *Science and Christianity* (Auckland: University of Auckland Centre for Continuing Education, 2001) 188,192.

112 Gunton, ref. 105, 72-73.

113 *ibid*, 100-101.

114 Hence the New Testament emphasis that God knows his people (Gal.4:9; 1Cor.8:3), just as they know God (Phlp.3:8,10; Col.3:10; 1Jn.2:3;2:13-14).

115 Hauerwas, S. and Willimon, W.H. *Resident Aliens* (Nashville: Abingdon Press, 1989) 53-55.