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## Understanding Human Origins

RESPONDING TO A QUESTION ABOUT HIS SOON-TO-BE-PUBLISHED *ON THE ORIGIN OF SPECIES*, Charles Darwin wrote in 1857 to Alfred Russel Wallace, “You ask whether I shall discuss ‘man’; I think I shall avoid the whole subject, as so surrounded with prejudices, though I freely admit that it is the highest and most interesting problem for the naturalist.” Only some 14 years later, in *The Descent of Man*, did Darwin address this “highest problem” head-on: There, he presciently remarked in his introduction that “It has often and confidently been asserted, that man’s origin can never be known: but . . . it is those who know little, and not those who know much, who so positively assert that this or that problem will never be solved by science.”

Darwin was certainly right. The intervening years provide conclusive evidence that it is very unwise to predict limits for what can be discovered through science. In fact, it now seems likely that, through synergistic advances in many disciplines, scientists will eventually decipher a substantial portion of the detailed evolutionary history of our own species at both the morphological and molecular levels.

First, what can we expect from paleoanthropology? In this 200th anniversary year of Darwin’s birth, *Science* is pleased to publish the results of many years of scientific research that suggest an unexpected form for our last common ancestor with chimpanzees. This issue contains 11 Research Articles involving more than 40 authors, plus News articles that describe the life and times of *Ardipithecus ramidus*, a hominid species that lived 4.4 million years ago in the Afar Rift region of northeastern Ethiopia. This region exposes a total depth of 300 meters of sediments that were deposited in rivers, lakes, and floodplains between about 5.5 and 3.8 million years ago. Even considering only this one site (there are many others), it is staggering to reflect on the huge number of hominid remains that can in principle be discovered, given sufficient time and effort. Moreover, the history of science assures us that powerful new techniques will be developed in the coming years to accelerate such research, as they have been in the past. We can thus be certain that scientists will eventually obtain a rather detailed record showing how the anatomy of the human body evolved over many millions of years.

What can we expect from a combination of genetics, genomics, biochemistry, and comparative organismal biology? We will want to interpret the history of the morphological transformations in the humanoid skeleton and musculature in terms of the molecular changes in the DNA that caused them. Genes and their regulatory regions control the morphology of animals through very complex biochemical processes that affect cell behavior during embryonic development. Nevertheless, experimental studies of model organisms such as fruit flies, worms, fish, and mice are advancing our understanding of the molecular mechanisms involved. New inexpensive methods for deciphering the complete genome sequence of any organism will soon accelerate this process, allowing scientists to analyze the recurring evolutionary morphological transformations that have been identified by organismal biologists,\* so as to determine the specific DNA changes involved. And the DNA sequences that have changed most rapidly during recent human evolution are being cataloged, providing a new tool for finding important molecular differences that distinguish us from chimpanzees.†

The majesty of the discoveries already made represents a major triumph of the human intellect. And, as emphasized here, there will be many more discoveries to come. Darwin’s summary of his own efforts to understand human evolution is thus still relevant today: “Man may be excused for feeling some pride at having risen, though not through his own exertions, to the very summit of the organic scale; and the fact of his having thus risen, instead of having been aboriginally placed there, may give him hope for a still higher destiny in the distant future.”

– Bruce Alberts

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\*R. L. Mueller *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **101**, 3820 (2004). †S. Prabhakar *et al.*, *Science* **314**, 786 (2006).