WHAT FORM WILL FUTURE HUMAN EVOLUTION TAKE?
By
William Reville, University College, Cork.

It is probably not a matter that often preoccupies you, but it can be fascinating to ponder the future path of human evolution. We know quite a lot about past stages in the evolution of life, and this gives some basis from which to peer into the future. However, predictions about the long term future must remain highly speculative. The area is not beloved of funding agencies and, so, not much is written on the subject. The American biologist Lynn Margulis is an exception. She has thought creatively on this matter and concludes that the long term future for humanity is to merge with its machine technological creations to form a new species, hardy enough to colonise the galaxy.

The earth was formed about five billion years ago. Many scientists believe that the atmosphere of the early earth was probably composed principally of the gases ammonia, methane, hydrogen and water vapour. Electrical storms and volcanic eruptions were common, and fairly intense ultraviolet radiation reached the surface of the earth from the sun. This combination of gases, radiation, electrical discharge, pressure and heat resulted in the synthesis of the basic chemical building blocks of life - amino acids, sugars, fatty acids, bases (basic components of the genetic material RNA and DNA), etc.

These various chemicals accumulated in the shallow seas of the time, combining and recombining with each other over a period of millions of years (chemical evolution) until eventually self-replicating molecules (ribonucleic acid - RNA) developed. RNA molecules could direct the synthesis of another important class of polymeric (made of many small monomer molecules, joined together) chemicals called proteins. Eventually, a more precise and stable form of self-replicating molecule developed, deoxyribonucleic acid (DNA), whose information content could be transcribed to RNA, which could in turn direct the synthesis of protein. Eventually these various classes of molecules became enclosed in fatty membranes and about 3.5 billion years ago we had the birth of the first living cell organised on the same basic biochemical plan that operates in present-day cells.

The first living cell was a primitive form of bacterium, a little membrane enclosed sphere about two millionths of a metre in diameter. The process of biological evolution now began, leading eventually to all of the life forms that inhabit the planet today.

Life began as a simple unicellular form, with an outside membrane but no internal membranes. We call this form of life prokaryotic. The cells of all higher animals and plants (eukaryotic cells) are much larger (fifty millionths of a metre in diameter) than bacterial cells and they have an elaborate system of internal membranes. Eukaryotic cells apparently developed from prokaryotic cells when one prokaryotic cell invaded another, without killing it, and established a symbiotic relationship which eventually became permanent. Eukaryotic cells contain much more genetic information than prokaryotic cells and have the capacity to do unique things such as forming large multicellular organisms. Eventually, about four hundred million years ago, multicellular life left the sea and mounted the land in the form of plants and animals.

The human brain and nervous system is a recent innovation. Less than two million years ago *Homo habilis* and *Homo erectus* appeared and it has only been little more than fifty thousand years since their descendents *Homo sapiens sapiens* originated in the Old World. By cooperating together, and with the aid of warm clothes and dwellings, they quickly covered the globe.

For the past two hundred years humanity has been producing machines at an accelerating rate. In the developed world human population numbers are stabilising but the reproduction rates of machines are increasing. In 1984, the United States robot population grew by 30% whereas the human population grew by about 2%. In many ways machines are also much more capable and powerful and change form at a much greater pace than mammals. Machines can out-perform humans at many tasks, can survive in a much wider range of environments and can be powered on a diverse range of energy sources - from combustion to nuclear energy.

Machines show many characteristics of a successful new living species - large size, rapid rate of mutation, aggressive reproductive rates etc. What about the ability to reproduce? Robots are presently used to make other machines (e.g. motor cars) - they could also make other robots. As time goes on, increasingly smarter robots are being made. I recently heard a Professor of Cybernetics declare that he has made robots having intelligence equivalent to that of a wasp and he foresees robots with intelligence surpassing human intelligence. It is true, of course, that machines are not alive in the biological sense, i.e. they are not based on carbon and guided by genetic information in DNA. However, since machines are devised by human ingenuity, and humans are carbon and DNA based, there is a sense in which machines are also based on carbon and on DNA.

Margulis broadly defines technology as the means whereby living systems maintain and advance themselves. She notes that every increase in complexity in the evolution of life is accomplished by subsuming the existing level into the new more complex level. Thus, the mechanism for making the first biological polymer molecules was incorporated as an essential aspect into the first living cell. These first simple cell types became essential components of the more complex eukaryotic cell. Eukaryotic cells in turn associated with each other to become subservient but cooperating units in whole multicellular organisms.

And that is where we stand today. It would be quite in keeping with this line of development for the next stage of human evolution to involve the co-mingling of humanity with its machine technology to form a hybrid species. Granted, this would seem to be a strange fruit on the tree of life, but does it strain the imagination any more than the commonly accepted scientific concensus that a living reproducing cell developed out of a chemical stew? Also, of course we are already familiar with several examples of the incorporation of mechanical devices into the body, e.g. artificial hips and limbs, dentures, etc.

There are pressing practical reasons why evolution might develop along the lines suggested by Margulis. Life as we know it cannot survive indefinitely on earth. Our sun has a life-span of only about ten billion years. In 5 billion years time the sun will have used up all the hydrogen fuel in its core and will expand into a red giant and radiate immense heat, evaporating our oceans, melting rocks and destroying the atmosphere. It will then shrink hundreds of times, eventually becoming a tiny spent dwarf star. Only life that has escaped our solar system will survive.

Our present human bodies are adapted to the benign conditions of earth. We can only tolerate a narrow range of temperature and pressure and we are irreversibly damaged by higher radiation levels. It is likely that most parts of our galaxy are very inhospitable to the physical human condition. We have to leave the earth eventually anyway, and we have already begun to explore our solar system and beyond. Our prospects of successfully colonising the galaxy would be greatly enhanced if we had much tougher bodies. Our long-term future form could well be a robotic skeleton, composed of tough metal and plastic parts, controlled by our biological nervous system.

(This article first appeared in The Irish Times, February 20, 1995.)