completely intrinsic to the molecule's structure but may depend, in part, on its environment. Given these uncertainties on the functionality of unknown molecules within our system, can we know everything about ourselves from our genomic sequence? The answer is probably not what we want to admit.

Many more years of research are required to even start answering the questions alluded to above. What we can assume is that knowing the sequence of the human genome will greatly facilitate this research. Proteomics represents the next generation of multi-million dollar projects that will attempt to identify and characterize all the proteins encoded by our 31,000 or so genes (5,6). As with genomics, the insight eventually gleaned from proteomics will represent another major step towards our understanding of ourselves. But perhaps the major question is still unasked – how many such steps will it take before we can consider our understanding complete and our interpretations definitive?

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THE 'BOOK OF LIFE': A GOLD MINE?

Together, the special issues of *Nature* (1) and *Science* (2) dedicated to the sequencing of the human genome amount to a stack of pages about 2.5 cm thick and well over 1.2 kilograms in weight. Complete with free CD-ROMs, gigantic posters, and a myriad of colourful advertisement are the reports of the (almost completed) human genome sequence. Yet these formidable volumes are merely the introductions to what is now being widely hailed as the Book of Life; actually, make that the 'Books' of Life. There are in fact two versions of this hallowed script, independently transcribed by the publicly funded International Human Genome Sequencing Consortium (published by *Nature*) and by the private venture Celera Genomics (published by *Science*).

The sequencing of the human genome is, even from the most mundane perspectives, an awesome feat. This powerful tool has already transformed the biomedical sciences so much, that some say with this information, we have now entered the 'post-genomic' age. But beyond its purely scientific value, the map of our own genome carries with it great symbolic significance. After all, it is the blueprint of ourselves that is now stored in databases and is accessible with but an internet connection and a few clicks of the mouse. The fifty years between the elucidation of the structure of DNA (3) and the completion of the Human Genome project will prove to be an enduring chapter in our understanding of ourselves.

Yet why would we need two versions of the same thing? Well, they are not exactly the same. For one thing, whereas the publicly funded version of the human genome is freely available in the public database known as GenBank, Celera's version can be accessed too, but with a number of strings attached. How this came to be is a story of meeting the bottom line – companies wanting to cash in on 'genomania'. Those who wish to download DNA sequences from Celera's database for free must be the purely academic ivory tower types who limit themselves to basic (read 'non-profitable') research. On the other hand, if researchers wish to go beyond the advancement of knowledge and apply their findings to develop clinical applications such as anti-cancer therapies, they will have to pay. In short, we didn't need to have two copies of the 'Books of Life'; the extra copy, which Celera claims to be more complete, is simply around because it can make money.

I am not trying to trivialize the achievement of Celera. Completing the massive project of sequencing the entire human genome ahead of schedule was by no means a walk in the park; quite the contrary, what Craig Venter and Celera Genomics did was very remarkable. Despite early criticism that his 'whole genome shotgun' approach to sequencing was impossible and unrealistic, it is now widely accepted as a standard method for future genomic projects. Furthermore, Celera is a company that has pumped millions of dollars into sequencing the human genome, so recouping this money (plus a little in profits) is not unreasonable. However, from an entirely different perspective, it does

seem that "in an era of heightened commercialism" (4) an overt and overwhelming obsession with the bottom line might potentially prove to be counterproductive, and hinder rather than promote scientific advancement.

The protection of intellectual property makes sense. It underlies the rapid progress in science and technology the world has witnessed since the Industrial Revolution. Basically, the patent system protects an invention from commercial competition. In doing so, it rewards innovation and provides an incentive for the long and forbidding process of research and development. It helps to focus our efforts on realistic projects that may have genuine potential for therapeutic or diagnostic value. However, the complexity of living organisms is daunting and threatens to overwhelm this system. For example, protein motifs, regulatory elements, and mutations can all be considered separate entities, and can thus be covered under different patents. However, it is only their integration as a whole that will constitute the final product. As a result, any useful therapy or diagnostic tool will probably accumulate a dizzying number of such 'stacked patents', to be resolved only through lengthy legal battles. Indeed, some estimate that it will cost around $100 000 to $500 000 to maintain just one patent over its legal life span in the United States – definitely good news for those practicing patent laws, but perhaps a woeful waste of time and resources that could be otherwise redirected to further research and development. Fortunately, many people are aware of the problem, and some have already proposed definite steps that policy-makers should take to avoid this situation (5).

The genomic patent chase has also produced other anomalies. For example, companies such as Incyte Genomics and Human Genome Sciences (HGS) have each filed over 7000 full-length gene patent applications. Considering the fact that the human genome is smaller than we had once believed, together these patents account for at least one-third of the total of 35 000 to 45 000 genes. Obviously the two companies cannot be doing research and development on all 14 000+ genes, gene products, and their interactions. Yet others whose research leads them to, for example, a possible treatment for cancer through the use of a peptide fragment encoded by a stretch of DNA hidden in the hypothetical file No. 6473 of one of these 'Catalogue of Patented DNA Sequences' will be infringing on the patent rights of a multi-million dollar genomics firm. This does not make sense: How is innovativeness and rationally risky research being rewarded here, when the right to develop promising therapeutics and diagnostics are concentrated in the hands of a few elite?

There are more questions to think about. For example, isn't there something fundamentally different between human genes and a toaster oven that can also make chocolate milk? Should we draw a line somewhere as to what we can reasonably claim to be our own? And what if Watson and Crick, the discoverers of the structure of DNA nearly 50 years ago, applied for and obtained exclusive use of DNA-related products? They would certainly be very rich, but would we have been able to read, in the first Spring of our new millennium, the "Initial Sequencing and Analysis of the Human Genome" or "The Sequence of the Human Genome", off the pages of *Nature* or *Science*?

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MEDICAL RESEARCH: FROM WAY OF THINKING TO WAY OF LIFE

Medical knowledge is progressing at a rapidly increasing pace and there virtually is not a week that goes by that doesn't bring its share of new technological advances or basic science discoveries. The question is should physicians lay by the wayside, leaving to others the excitement of new discoveries and the responsibility for setting the medical agenda, or should they actively take part in this unprecedented scientific adventure? Can they truly play a meaningful role in research and still find the time and resources to take proper care of their patients? For example, the cloning of the human genome has opened fascinating new windows of opportunities for investigating the cause of, and hopefully bringing new cures for, human health disorders. But it has also raised a number of new moral and ethical issues that