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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REFERENCES

1. International Human Genome Sequencing Consortium. Initial sequencing and analysis of the human genome. Nature 2001; 409: 860-921.
2. Venter JC, Adams MD, Myers EW, et al. The sequencing of the human genome. Science 2001; 291:1304-1351.
3. Watson JD, Crick FHC. A structure for deoxyribose nucleic acid. Nature 1953;171: 737.
4. Marshall E. Sharing the glory, not the credit. Science 2001; 291:1189-1193.
5. Bobrow M, Thomas S. Patents in a genetic age. Nature 2001; 409: 763-764.

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

physicians are perhaps better equipped to deal with than non-medically trained scientists.

Medicine is an art, but one that cannot be dissociated from science. For one, proper medical training requires solid scientific knowledge. Physicians, even if they are not to become scientists themselves, must learn to follow and understand the progress of health sciences research, if only to appreciate the validity and implications of new findings and to be able to offer their patients optimal medical care. They should therefore familiarize themselves with reading and interpreting scientific literature (and this journal offers them a unique opportunity to do so). However, nothing surpasses hands-on experience and active participation in a research project as the best way to train the mind to think scientifically.

Some will want to go further and to acquire full scientific training in addition to their medical one. They can do so early in their careers, through joint MD/PhD programs, or later during or after their residency program. These individuals will be called upon to play a critical role, not only for the establishment of medical research priorities, but also for ensuring transmission of research results from the bench to the bedside. Indeed, no one will be better poised to understand medical science, relevant questions and pressing needs. No one will be better prepared to interface with scientists of many disciplines, from the biomedical to the psychosocial, from population health to health care delivery.

Together with other health care professionals and their scientific colleagues, clinician-scientists share the responsibility for transmitting scientific knowledge to health care providers and for training future science and medical students. How realistic is it to attain this goal? Are clinician-scientists competent physicians? Competitive scientists? Obviously, the door is narrow and commitment must be strong, but the rewards are exceptional and the benefits, to self and society, are immense.

The required prolonged training calls for appropriate financial support. All granting agencies, particularly the Canadian Institutes for Health Sciences (CIHR) at the federal level and the Fonds de la recherche en santé du Québec (FRSQ) at the provincial level, offer research training grants for medical students and health care professionals. For instance, both CIHR and FRSQ provide stipends for students involved in MD/PhD programs. Both agencies also offer fellowships for health care professionals intent on acquiring research training, whether formerly, within the framework of a structured PhD program, or less formally, as a complement to their residency training. And afterwards? Again, both CIHR and FRSQ offer clinician-scientist awards to allow health professionals to share their time (usually 50/50) between clinical practice and medical research. They offer half-time salary support as well as, in the case of FRSQ, money to help young clinician-scientists set up their laboratory.

In summary, all medical students should consider research exposure as part of their training if they are to keep up with the rapid evolution of medical knowledge and to provide optimal and up-to-date medical care to their patients. Furthermore, it is critical for the future of health sciences research that physicians continue to play an active role on the research front while maintaining leadership in medical care. Governmental granting agencies have recognized this need and will provide the necessary support should you elect to take this difficult but exciting path.

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