CQ Interview

Chris Shaw on Ethical Issues in Biotechnology

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Chris Shaw is the Chair of Biotechnology and Head of the Pharmaceutical Biotechnology Research Group at the University of Ulster in Northern Ireland. His concern for the unequal distribution of benefits has prompted him to take a leading role in developing partnership models for scientists doing research in underdeveloped countries.

Thomasine Kushner: What is your background and what brought you, as an academic, to biotechnology?

Chris Shaw: For 26 years of my career I worked in the medical school in Queens in Belfast. My interest was in the neuroendocrine system and on the peptides that control virtually every bodily function. Toward the end of that period, I developed a great interest in biotechnology, seeing it as the industry for the future and the way forward.

In a very traditional university, such as mine, there was little understanding of applied biomedical research and even less encouragement for creative researchers, so I moved to the other university in Northern Ireland, the University of Ulster, which has a very active policy in the commercialization of research. I still maintain my interest in peptides, and now it is being recognized that these molecules are the messenger molecules of the body; they are the way in which cells "speak to one another" generally.

My interest was sparked by what seemed to me as the enormous commercializing potential of the area I was studying. Amphibians, for example, produce vast arrays of chemicals in their skin secretion. Some of the cocktails that they secrete contain hundreds of different peptides; many of them are targeted, cruise-missile fashion, at various receptors in their predators. Many of the predators are vertebrates, just like ourselves, so an inventory of these molecules can come up with new structures that interact with known or new receptors.

TK: Since moving into biotechnology and commercialization of scientific discoveries, what are the major ethical issues you face?

CS: Our primary interest in biotechnology is in exploiting biodiversity, looking for new drugs in nature, and there are several different levels of ethical issues in what we do.

The first one is that until quite recently, the major thrust of many pharmaceutical companies in natural product chemistry was to send scientists off to exotic locations in search of specimens. However, many of the areas

Cambridge Quarterly of Healthcare Ethics (2002), **11**, 97–101. Printed in the USA.
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https://doi.org/10.1017/S0963180102101162 Published online by Cambridge University Press

containing the richest biodiversity are in underdeveloped countries. It was a case of the large pharma that were going into these countries sampling a wide range of plants used in traditional medicines or just randomly sampling for new drugs.

At the end of the day, there was little, if any, benefit to the (often underdeveloped) country of origin. In hindsight, it may be that many underdeveloped countries would be developed countries today had they received even a small percentage of the royalties of the profits that were produced due to the lead compound having been discovered in their country.

At the initiation of our program, we decided that this was the major ethical issue we had to deal with. Today the technology is so advanced that even a relatively small group working in an academic institution is capable of finding a new drug or a new compound. Therefore, we decided right up front that we would form partnerships with either academic or government institutions within these developing countries. From the outset we would say, "You have the natural biodiversity, we have the technology, and what we want to do is form a partnership with a signed agreement stipulating that any monies that come from patenting or exploitation of your natural compound that we have isolated and characterized will be split evenly on a 50/50 basis."

Although we work within the structure of a completely equal partnership, I think our arrangement offers something even better. We provide doctoral scholarships to students from the country to come to our university and be trained in our discipline. Over a 3–5-year period these individuals go back to their country and continue with a collaboration with us, and ultimately what we hope to achieve is autonomy for the science base of that country to tap its own natural resources.

In the last two years our major success has been with the People's Republic of China, where we have signed an agreement with the University of Fuzhou, which is the major port city in southern China, immediately opposite Taiwan. Currently we have three students training for Ph.D.s in our department. We are also in the process of setting up a research institute in Fuzhou, where I will spend several months a year supervising students.

Historically, the problem of unequal distribution of benefits has been a serious one for scientists doing research in underdeveloped countries, and I sleep very easily in my bed at night because of the solution we have put in place.

The second major ethical issue is again a reflection of what happened in the past when scientists would go into these underdeveloped countries, collecting, perhaps several thousand plant or animal specimens, and the whole process required destroying these species.

In our laboratory, our major focus is on the venomous skin secretions of amphibians. By reevaluating old technologies, we have adopted a technique where the secretions can be obtained totally noninvasively, without harming the animal in any way. Recently, we have developed another technique that involves a methodology of determining the genetic coding of the material, which again, does not involve sacrificing or harming the specimen. With our advanced technologies, we are able to go into the habitats, capture the specimens, digital-image photograph them, noninvasively obtain the desired samples, and return the animals completely unharmed.

These are the ways we have dealt with the ethics of our situation: by developing partnership agreements and

https://doi.org/10.1017/S0963180102101162 Published online by Cambridge University Press

modifying our technologies so that, unlike what was customary practice, we are not removing specimens and we are not changing male-to-female ratios with resulting damage to biodiversity of our host countries. I believe we have created models that are hard to surpass.

TK: Biotechnology seems to be an area with no firm boundaries or classifications. How do you define the term "biotechnology"?

CS: First of all, biotechnology is not a really new area of science. In fact, one might actually argue that biotechnology is possibly the most ancient bioscience in human culture when one considers that beer, wine, cheese, and bread, virtually all the staples of a primitive human diet, are all biotechnology products. They all use some attribute of living systems to produce the product. In beer and wine we have part of the yeast in terms of fermentation, in cheese there is microbial degradation of products to produce flavors and textures, and likewise in bread, the use of yeast in raising bread and producing carbon dioxide. So, these are very ancient processes and it intrigues me that millennia ago in our past we had already, even if we did not know it at the time, harnessed these processes by biotechnology.

Biotechnology today is virtually an all-embracing term, a multidisciplinary science that reflects a broad spectrum of expertise including ethnobotonists, natural history people, conservationists, biochemists, physicists, molecular biologists, and engineers. Many people now believe that the great breakthroughs in science will no longer come from the straight single entities but instead from scientists getting together and doing interdisciplinary research. The analogy I draw is that although scientists customarily live on mountain peaks, we would do well to remember that the real richness is often found in the valleys. It is in the riches washed down and mixed in the valleys where the great discoveries will take place, and I think recent years have borne this out.

At our own institute in Ulster, biotechnology used be a single unit but we have now split that into two different divisions. One division, "environmental biotechnology," involves such things as bioremediation. For example, if a company is putting effluent into a river, we can harness the power of microbes to detoxify and change it into more harmless materials, or we can actually remove some of those agents for recycling. Similarly, virtually every major industrialized city, town, and village on earth has its own sewage treatment plant. One can imagine what the environment would be like without our ability to harness the power of the microbe to detoxify our own waste.

In addition to the environmental aspects of biotechnology, the other group we have formed has to do with "pharmaceutical biotechnology." By this we mean biotechnology research themes or programs that are directed against biomedical disciplines—that is, the discovery of new molecules, targets, or drug leads that can unravel processes that we do not understand as yet, as for example, in tumors and tumor metastasis. So, we see biotechnology as encompassing these two very broad areas of endeavor: the environment and bioscience.

TK: What would you say to protesters who challenge biotechnology as more threat than benefit to society?

CS: You may be astonished by what I am going to say, but I would say "Keep up the questioning." Scientists generally around the world are very poor

https://doi.org/10.1017/S0963180102101162 Published online by Cambridge University Press

communicators. We often lack the skills to explain to the general public what we are doing in a rational and tangible way. In my research group we take great pains to bridge that gap. We make videos that go around the world, we have high school and college students spend time with us, and we explain our work to them. We try to make our science user-friendly so it can be easily understood by the public.

In a sense, having a lobby like anti-biotechnology protesters should spur the scientists to develop communication skills and come out and answer the public's questions. Also, it is always good when you are working and moving ahead on a project to have the opposite point to challenge your assumptions.

However, there have to be limits. From my own experience in the United Kingdom and our debate on genetically modified food, to be truly valuable arguments have to be based on facts. The point I made to our local media was, "Yes, by all means, be cautious, but remember that scientists are among the most cautious people on earth. We are not mad persons in white coats hiding in laboratories behind closed doors. We have families, we have aspirations, we eat the same food as everyone else, we are members of the general public ourselves."

The point should be made that genetically modified foods have been produced and consumed in the United States for at least 10 years. If you look at genetically modified crops globally, there is not one proven example of a human illness or a human disease having been caused by the ingestion of genetically modified food. Contrast this situation with alcohol consumption, another biotechnology product. Alcohol is a huge burden on healthcare and law and order resources. Apart from the diseases that alcohol induces, as well as other social problems, look at the problems of drunk driving and general violence. Yet, alcohol is freely available and can be purchased in supermarkets. Here is a biotechnology product that has deleterious effects that are beyond any argument whatsoever.

So, what I am saying is "Let's look at things in perspective. By all means be cautious and by all means try to prevent, but don't blow things out of all proportion when there is no evidence—please back your arguments with the facts."

Life is a risk, and everything that we do as humans is risky. According to statistics, probably the most dangerous place in our environment is our own home. We are more likely to be wounded or fatally injured in our own homes than we are in the street. Driving to work is risky, as is a job that is stressful. Our societal progress has been forged from risk: doing the first surgery, and later keyhole surgery; sending a man into orbit, and then to the moon. At every step we assess the risk, we balance benefits and burdens and move forward.

My message is to encourage people not just to protest, but to keep the debate alive and work toward bringing scientists and the general public together in a forum for discussion and education. As scientists we should welcome not criticism per se, but informed debate based on facts and logical analysis rather than emotions.

TK: You've described biotechnology as the science of the millennia. What do you see in that future?

CS: Crystal ball gazing, especially in science, is fraught with dangers. Predictions often do not materialize, but unpredictables do. However, I tell my students that if, over the next 10 or 20 years we encounter an extraterrestrial intelligence, that intelligence will almost certainly be a biotechnological one. The

https://doi.org/10.1017/S0963180102101162 Published online by Cambridge University Press

use of the processes that have evolved in living things for societal benefit is probably the greatest leap forward that any intelligence or intellectual species can actually make. We are already beginning to realize that in terms of space travel, inside a space station, or module that circles the earth or travels to the moon, is a process of recycling and regeneration, largely using biotechnological processes. For longer interplanetary journeys, or beyond, these processes will need to be biotechnological, as sustainability will be a limiting factor. I've made that prediction, and maybe within my lifetime that will be tested.

In my view, the biotechnology revolution may well be the second major leap forward in human society, the first being the industrial revolution. I believe the planet, as we now know it, will change very dramatically over the next 50–l00 years as the power of biomolecules is actually realized for a whole host of different processes. From my perspective, biotechnology has a very bold and bright future and will become a major component of global economics; and who knows, by growing and expanding the biotechnology industry, the world may well be a better and more ecologically balanced place in 50 years' time because of it.

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