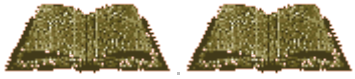
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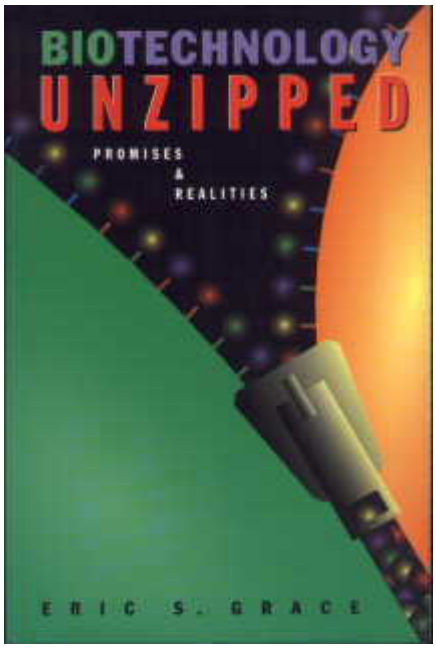
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THE PROMISE OF BIOTECHNOLOGY

Biotechnology Unzipped - Promises and Realities 1st Edition *by* Eric S. Grace
Joseph Henry Press, (An imprint of National Academy Press), 2101 Constitution Avenue, NW, Lockbox 285, Washington, DC 20055, , (Washington Metropolitan area), : xvi + 248 Pages: Publication Date - 1997, ISBN 0-309-05777-9: Price $18.95

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Everyone seems to be talking about biotechnology these days. But does everyone understand what exactly is it? As the author of this immensely readable book explains in his preface, "it isn't easy to explain what biotechnology is, and what it is not, in only a few sentences". Many people confuse it with just genetic engineering. Many others take it to be a technique by which genetically altered bacteria - in some mysterious way - churn out newfangled medicines and vaccines. But as the author explains in the very first chapter (and he does that quite remarkably in just one sentence), it is "an umbrella term that covers various techniques for using the *properties of living things* to make products or provide services".

"Properties of living things" appears to be the underlining phrase here. It is a property of fermenting bacteria to turn milk into curd, or sugar into wine. It's the property of sheep to produce wool. So is making of curd, wine or producing wool an example of biotechnology? If it is, then man has been using biotechnology since the dawn of civilization.

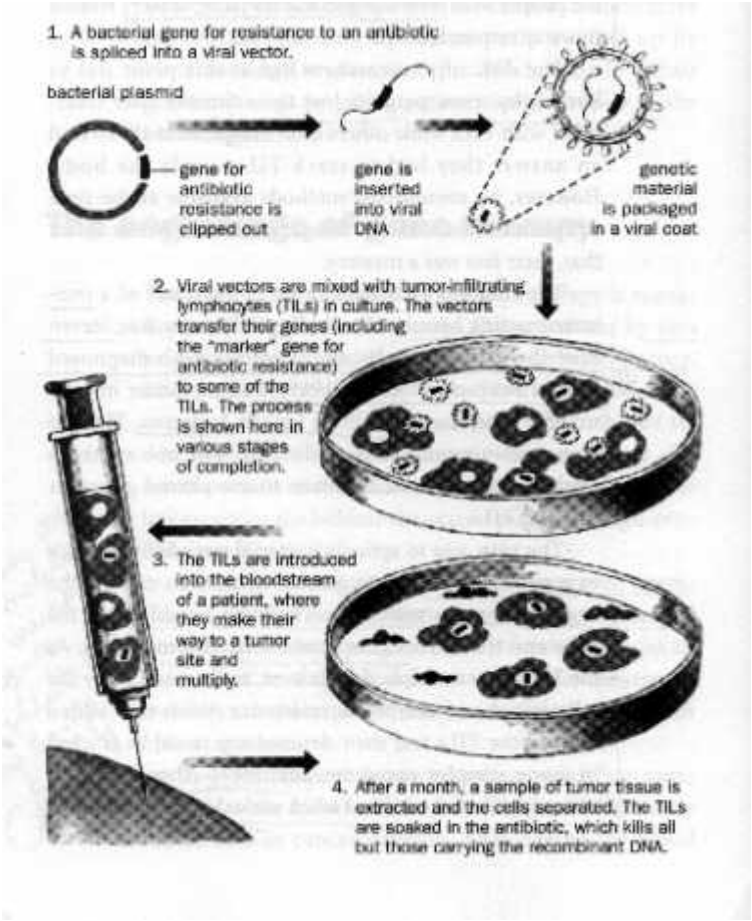
Although these examples do fit in quite snugly into our definition of biotechnology, *modern biotechnology* is definitely not this. As the author informs us, "what's new about modern biotechnology is not the principle of using various organisms, but the techniques for doing so. These techniques, applied mainly to cells or molecules, make it possible to take advantage of biological processes in very precise ways." At another place, the author further clarifies the definition. "Down among molecules, there is really no difference between a person and a bacterium. What biotechnology does is choreograph the complex dances among molecules that ultimately make every living thing what it is."

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From these explanations, we can distil out certain important tenets of biotechnology. Firstly, it involves using the properties of living things in certain ways to make products or provide services. Secondly it involves *changing* these properties in certain specific, precise and predictable ways, in order to suit human beings, and lastly this change is more often than not at a cellular or molecular level.

One of the interesting features of this book is the liberal use of flow diagrams such as these, which make the accompanying text very easy to understand. This diagram appearing on page

66 attempts to explain how doctors tried to keep track of TILs in a patient's body by incorporating a bacterial gene in it (see review for details)



The book is divided in seven chapters. The first two chapters are basic in nature, and serve to introduce the reader to the world of biotechnology. After explaining what biotechnology is all about, the first chapter outlines the scientific background that made biotechnology possible. From the experiments of the English scientist Robert Hooke, who studied and named cells in 1665, we are driven through a history of biology, till the modern era when Watson and Crick finally cracked the structure of the DNA. In between we learn about the achievements of Anton van Leeuwenhoek, Matthias Schleiden, Theodore Schwann, Charles Darwin, Gregor Mendel and a number of other brilliant scientists who made the astonishing march towards modern biotechnology possible.

The bulk of the book is formed by chapters 3-6. In each of these four chapters, one major area where biotechnology has made our life different is described. In chapter 3, we are told about the role of biotechnology in modern medicine, in chapter 4 its role in agriculture, in chapter 5 its role on environment and in chapter 6 its role in harvesting the oceans and trees. Chapter 7 looks mainly at ethical issues.

A remarkable feature of the book is that it has been written in a completely non-technical language, making it easy for an average reader to be able to understand and enjoy this book. Amazing facts are presented in each chapter which introduce us to the wonders of biotechnology. I would like to give an example from some of the chapters.

Biotechnology's role in medicine? Back in 1986, researchers found that patients with certain cancers showed certain special kinds of white blood cells called the tumor-infiltrating lymphocytes (TILs). These cells would invade the tumors and kill tumor cells. However ultimately they (TILs)

would lose out the battle, perhaps because they were too few in number. Was it not a good idea to culture these cells, grow them in great numbers and reintroduce them in the cancer patients' blood vessels? This is precisely what the doctors did. However much to their surprise only about half the patients of terminal melanoma (a kind of skin cancer) responded well. The other half simply failed to respond.

What happened to the TILs in these patients? It was necessary for doctors to know the answer to this question, if this line of treatment had to be developed and improved further. To know the answer, the cells had to be "tracked" somehow in the patients' body. And biotechnology immediately provided the answer. The scientists introduced a bacterial gene responsible for antibiotic resistance in these TILs and wanted to reintroduce these cells in the patients' bodies. These genes would not be doing any treatment at all. They would merely be acting as a "marker gene". If after a few months, the patient's blood was drawn out and treated with an antibiotic, all cells would die barring those that had the "antibiotic resistance gene" incorporated in them. And thus doctor could "track" the TILs.

But would the opponents of biotechnology allow such a move? After all, doctors were trying to "cross" a bacteria with a human, albeit at a cellular level. Not only were they attempting the "cross", they were trying to put the resulting chimera back in the patients' bodies. Will such a move be allowed? The author discusses this very well on page 68. A historic meeting of the full Recombinant DNA Advisory Committee (RAC) was held on October 3, 1988 to decide on the fate of this landmark procedure. The difficulty was that data from animal experiments was not available. This was because mouse TILs would not accept genes from viral vectors. There were both molecular biologists and physicians in this committee. Molecular biologists were more wary of this procedure than the physicians. This could perhaps be understandable as it were the physicians who were working among the sufferers. They were the ones who had seen suffering at close quarters and wanted to help their patients, whatever the risks involved. In the end the experimental treatment was approved with a vote of 16 to 5, all five dissenting voices coming from molecular biologists. It was a rational decision, as the procedure was to be tried in terminal patients of cancer and it is virtually not possible to have more risk than certain death!

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Following this historical approval gene-marked TILs were given to a 52 year old patient of malignant melanoma. His name was Maurice Kuntz and before the procedure the doctors had given him just two months to live. What happened to him? Readers may like to find out the result from the book itself.

Applications of biotechnology in agriculture rank second only to those in medicine. In chapter 4 entitled "Biotechnology on the farm", we are introduced to some of these wonders. Some of the applications that immediately come to mind are the development of plants that can survive droughts, frost and other environmental stresses, resist insect pests and diseases and tolerate herbicides, so farmers could use them more freely. It can also mean production of designer milk for, say, yogurt production or for lactose-intolerant consumers.

Agricultural biotechnology has found so much use in day-to-day life that today major corporations are thriving on just this technology. We are told that Monsanto is a major biotechnology corporation with 30,000 employees and net sales of almost $10 billion per year! It makes *Posilac*, the commercial name of Bovine Somatotropin (BST), which is used to increase milk production in cows. What are the controversies involved? What are the benefits? What is its current status? We are told all about it and much more in this chapter.

Much less is known to the layman about the role of biotechnology in improving the environment. In chapter 5 entitled "Biotechnology and the environment" we are told of such procedures as biomining, bioleaching and bioremediation. What are these? The reader would do well to learn about them from the book itself, but I will explain a little bit about biomining, mainly because it sounds such a novel concept. Bacteria can now be used to recover metals from low grade ores, and tailings. Sulphur present in copper mines creates problems, as it makes recovery of copper from the ores very difficult. Any ore with a high sulphur content is thus considered a low grade ore. A particular oxidizing bacteria *Thiobacillus ferrooxidans* can oxidize the sulphur in the ore and make the recovery of copper from such ores economically viable. This is biomining. The details are nicely explained in the book, with relevant photographs.

One of the remarkable features of this book is that it gives small chunks of information in small boxes off and on. These boxes are spread out throughout the book. And they are very helpful "to get the reader to the scene so to say". One can shuffle through the pages, stop at these boxes at random, read and be able to enjoy them quite independent of rest of the text. And in the process he gets enough background information on that chapter, should he wish to tackle the entire chapter later on. Another good feature is the liberal use of line diagrams.

To summarize, a very useful book for all and sundry, especially those interested in knowing the impact of biotechnology in our day-to-day lives. Fully recommended to all.

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