CHAPTER 1

Sharing the Excitement of Discovery

The pace of change is accelerating and has been since the inception of invention [and] this acceleration is an inherent feature of technology. The result will be far greater transformations in the first two decades of the twenty-first century than we saw in the entire twentieth century.

—Ray Kurzweil, author and inventor[1]

PACE OF CHANGE

As humankind stands on the edge of a new millennium, it is interesting and informative to take a look backward, and measure how far technology has advanced in the last 1,000 years and understand why the pace of change has accelerated so rapidly in just the last 100 years, and why it will continue to accelerate at an even faster pace over the next 100 years.

A millennium ago, the most advanced practitioners of the art of healing lived in the Ottoman Empire. The skills of these medical practitioners were essentially derivative, in that their primary goal was to interpret and revive the medical knowledge developed by Hippocrates, Galen, and other physicians of the Greco-Roman era. Indeed, in the year 1000, western civilization knew less about medical science than its ancestors did 2,000 years ago.

Throughout the Ottoman Empire, the most famous physician was Avicenna, a Persian, who wrote the million-word textbook, *Canon of Medicine*, which was considered to be the defining treatise on medicine until well into the seventeenth century.

A millennium ago, written language was reserved for society's elite. The Guttenberg printing press had not yet been invented, so the dissemination of information was a slow, painful process. For the average person, storytelling

(either oral or through the visual arts) was the most common means to communicate ideas between villages or across generations. To communicate across distances required the physical travel of a human being, which greatly limited the dissemination of information.

By the turn of the 20th century, the level of knowledge had increased tremendously. In medicine, vaccines were developed. Knowledge of germs as the source of infection was proven by Louis Pasteur in France, and this led to the first attempts at preventive medicine and the development of theories of immunization. Also at this time, the specific microbes responsible for tuberculosis and cholera were discovered by Robert Koch in Germany.

In communication, voice transmission over phone lines had become available, which made possible verbal communications between people who were miles apart. King Kalakaua, sovereign of the small and far-off kingdom of Hawaii, was one of the first monarchs to install a phone line in his palace, allowing him remote communication with his staff. By 1878 the first commercial phone exchange was put into service in New Haven, Connecticut, and AT&T was born.

The other communication breakthrough that occurred at the end of the 19th century was the teletype or teleprinter. This technology was in widespread use for over 50 years and only recently was rendered obsolete by computer printers and visual displays.

Within the last 20 to 40 years, the knowledge boundary has been pushed even further, and the pace of change has picked up considerably. The genetic code has been cracked; monoclonal antibodies have been produced; the human growth hormone has been synthesized; human insulin has been produced in genetically modified bacteria, becoming, in 1982 the first biotech drug approved by the Food and Drug Administration. Technology for "golden rice" recently has been made available to developing countries in hopes of improving the health of undernourished people and preventing some forms of blindness; the DNA fingerprinting technique was developed in 1984, and one year later, genetic fingerprinting was entered as evidence in a courtroom; the Human Genome Project, an international effort to map and sequence all the genes in the human body as well as the genomes of key experimental organisms such as yeasts and nematode worms, delivered an initial analysis of the sequence fully two years ahead of schedule. The implications of these and countless other breakthroughs on disease treatment and food production are enormous. Biotech and genomics have revolutionized the industry, approaching disease from its source and not its symptoms. Real cures are emerging as science comes to understand causation at the genetic level.

In communications, we now send and receive a wide variety of data instantly and globally. These transmissions include text, images, and sound, and enable users to access vast sources of information stored in databases from remote locations. In 1990, when researcher Tim Berners-Lee developed

the HyperText Markup Language (HTML), the concept of a global communications network was understood by very few. Just four years later the World Wide Web emerged and has arguably become one of the most important technological breakthroughs in the history of humankind.

Today's computers are performing tasks that were considered unthinkable just a decade or two ago: real-time voice recognition, responding to natural language, recognizing patterns in medical procedures, and so on. It is estimated that computers doubled in speed every three years at the beginning of the 20th century, every two years in the 1950s and 1960s, and are now doubling in speed every 12 months.[2]

But the high-tech and biotech industries are not solely functions of advances in science. These industries are actually defined by *two* spheres, of which science is only the first. The second sphere is business—the ability to introduce new products valued by customers into the marketplace.

> *Venture capitalists invest for the long term. I think, and most of my colleagues would agree, there is a great future in this area and a wealth of opportunity. The thing to remember is that the science moves on extremely fast, and the key question is how you harness the science into a viable business model.*
>
> —Nicholas Galakatos, Ph.D., Former Partner, Venrock Associates (now Vice President, Millennium Pharmaceuticals, Inc.) [3]

Like the underlying technology, the nature of business has changed dramatically over the last millennium. A thousand years ago, society was largely based on agriculture, and great wealth accrued to large landholders. Commerce was conducted predominately at the individual level; for example, a cobbler or a draftsman plied his trade to others in the same town. Conducting business usually required the physical presence of all parties, such as a farmer's market in the town square, which brought together all the farmers, their products, and their customers.

In the 19th century, the Industrial Revolution changed the scale of business dramatically. Manufacturing and production were performed by large factories and, in order to build these, access to capital was critical. For the first time, large numbers of investors outside of the company itself were needed to build factories and realize economies of scale. And so the corporation as we know it today began to emerge. Since the Middle Ages, business had been conducted at the whim of a sole proprietor or a small partnership. The emergence of a corporation—with multiple divisions and responsibilities and managements—changed the world of business forever.

Once again, the size and nature of business is changing. To compete successfully, companies must be lean and nimble, able to respond quickly to changing market conditions. Sheer size alone does not guarantee a sustainable

competitive advantage, and neither do traditional economies of scale. Instead, *knowledge* and *information* are seen as the key resources for companies that allow them to provide value to their customers. Finally, it is no longer necessary to establish physical locations for the conduct of commerce. With Internet technology, companies establish virtual marketplaces from which they sell their goods on a worldwide basis.

These changes—in the world of business as well as the world of science—are the driving force behind opportunities in the high-tech and biotech industries.

CHARACTERISTICS OF HIGH-TECH AND BIOTECH COMPANIES

> *Think about the nature of innovation in the drug industry. What exactly does it take to have the kind of scientific breakthrough necessary to create a new drug, one with significant therapeutic value?*
>
> *In short, it takes entrepreneurial spirit and scientific insight.*
>
> *You can array data that is common knowledge across the industry and ask ten scientists, "Is there a drug in there or not?" Nine will tell you no, and one person will say yes. Maybe that one person is wrong, and maybe that one person just found a breakthrough, it happens all the time. That intangible element of insight makes all the difference in our industry.*
>
> —Judy Lewent, Chief Financial Officer, Merck & Co. [4]

High-tech and biotech companies operate in separate industries with vastly different products, yet they share important similarities. These similarities stem from a common goal, namely to capitalize on scientific insight and create products valued by customers. The following characteristics are common to both high-tech and biotech companies.

- Success in the medical, communications, or any other technology-driven field requires a steady flow of innovative products. To create these new products, high-tech and biotech companies are extremely research intensive. The Biotechnology Industry Organization (BIO) reported that the biotechnology industry is one of the most research-intensive industries in the world and that, in 2001, the United States alone spent $15.6 billion on research and development (R&D). Similarly, the BIO reported that the top five biotech companies spent an average of $89,400 per employee on R&D in 2000, while the average for all U.S. industries is about $8,000 per employee.
- The structure of the company must be compatible with this research-driven nature of the business. According to Gabriel Schmergel, president

and chief executive officer (CEO) of Genetics Institute, Inc., "Innovation thrives better when decentralized. The truly innovative people tend to migrate away from the large organizations, whether academic or industry, and move to smaller ones. That is where true innovation is taking place."[5]

- High-tech and biotech companies tend to be smaller with fewer employees, and disparate functions exist side by side rather than in the different departments found at larger corporations. The aim is to be able to translate ideas quickly into action. Technological change is rapid, and the company must be able to keep pace.
- The working environment of high-tech and biotech companies tends to attract people who are motivated by an intellectual curiosity and drive. It is common for high-tech and biotech companies to offer their employees stock options and other forms of equity-based compensation, such as restricted stock and restricted stock units. Microsoft recently announced the suspension of stock option grants. The company will replace its option granting program with a program focused on restricted stock units. The goal of all these forms of equity-based compensation is to provide a strong incentive for performance and create for the employees an intense, personal stake in the company. Stock options are also valuable because they help the company conserve its cash.

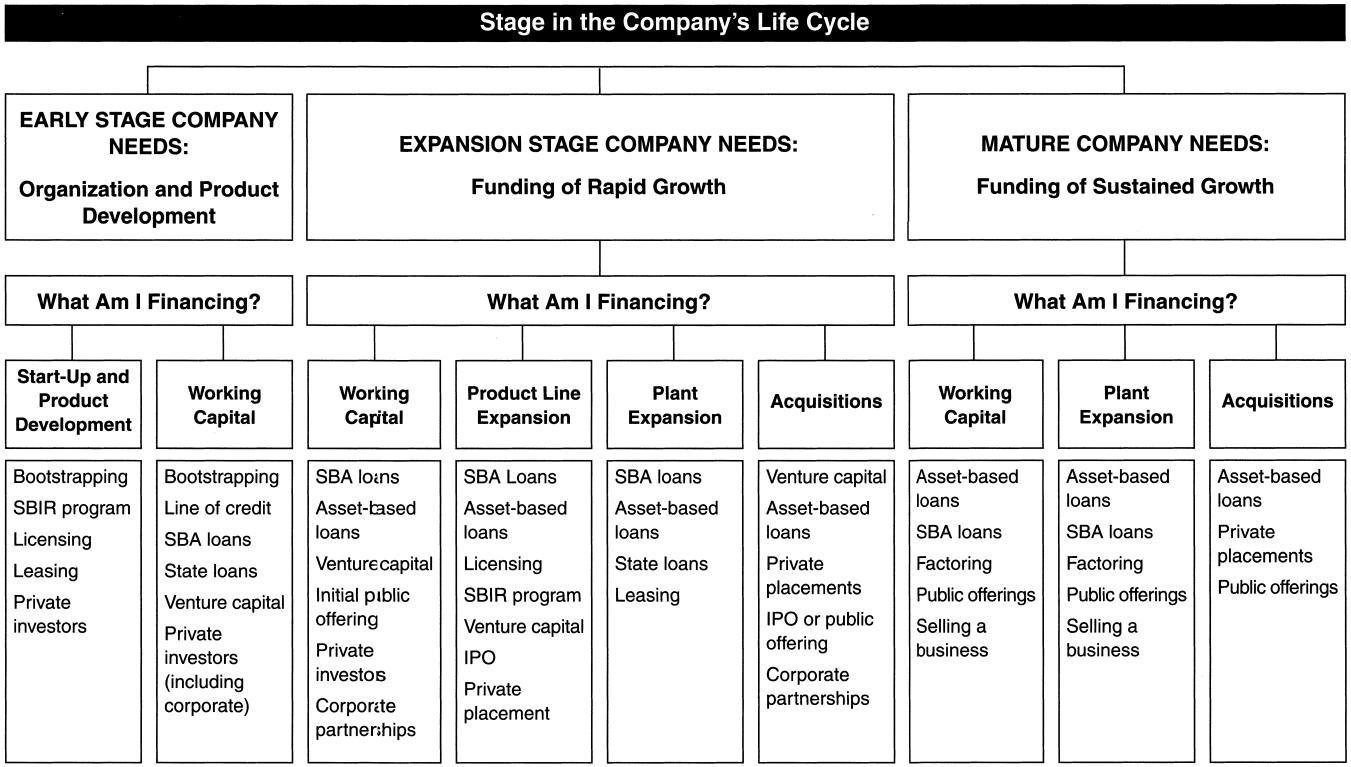
NEED FOR FINANCING

Perhaps the most important characteristic shared by high-tech and biotech companies is the long lead time required before products are sold and revenues are realized from research projects. Financing this research and product development can take hundreds of millions of dollars, and there is no guarantee of ultimate success. For example, in the biotech industry it takes, on average, in excess of $500 million and 10 years to bring a drug to market. Once there, 7 out of 10 products fail to return the cost of the company's capital.

CEOs of high-tech and biotech companies are under tremendous pressure to continually raise financing from a variety of sources. Unfortunately, as the high-tech and biotech industries have matured, investors have become more pragmatic and cautious about the companies they back financially.

> *Merck invests approximately $1 billion per year in research, which has given us extraordinary insights into the risky nature and high cost of pharmaceutical research. We know that scientists will probe an idea they feel has merit for as long as they possibly can, which is great. You get advocates, you get champions, and you never say die. The challenge from the point of view of the finance department is*

EXHIBIT 1.1 Financing Decision Tree



Abbreviations: SBA, Small Business Administration; SBIR, Small Business Innovation Research.
Source: The Financing Decision Tree was developed by Meryle J. Melnicoff, Ph.D. and is being used with permission.

to put parameters around that curiosity and determine what is and what is not productive.

—Judy Lewent, Chief Financial Officer, Merck & Co. [6]

The high-tech and biotech CEO face many barriers in the attempt to raise money and, once raised, additional problems arise in trying to control costs and manage the "burn rate." This book describes the ways high-tech and biotech CEOs might overcome those barriers and problems.

The book begins with a technology frontier overview followed by an overall discussion of business growth models that encourage others to invest. Succeeding chapters provide insight on how financing is obtained from venture capitalists, the public markets, and corporate partners. Case studies and observations from technology company CEOs are used to demonstrate how key ideas are applied in practice. The book includes a discussion of tax- and equity-based compensation strategies that can be effective in helping companies conserve their cash as they strive to move their new technologies from concept to reality. And this new edition also covers mergers and acquisitions within the biotech arena as well as a discussion of global biotech and the new emphasis on corporate governance since the passage of the Sarbanes-Oxley Act, and ends with a view of technology's future—from the frontier.

FINANCING DECISION TREE

The type of funding to seek depends on the company's stage of development and how it plans to use the financing. Only a few of the various financing sources are appropriate for a given business at each stage of its development. Exhibit 1.1 outlines the different sources of financing available throughout a company's life cycle. Many of these financing alternatives are discussed in later chapters of this book. Of course, since each company is different, so is its business and financial situation. The information contained in this book is intended as a guideline only. Any decision to seek and accept financing from a specific source should be made only after consulting with legal and financial advisors.

NOTES

[1] Ray Kurzweil, *The Age of Spiritual Machines* (New York: Penguin Books, 1999), 2.

[2] Ibid., 3.

[3] Nicholas Galakatos, "What's New in Biotechnology Funding," Presentation at the annual meeting of the New York Biotechnology Association, October 1995.

[4] Nancy A. Nichols, "Scientific Management at Merck," *Harvard Business Review* (January–February 1994): 98.
[5] Erik Christenson, "Profits, Promise, and Positive Results: Biotechnology at 20," *Fortune*, September 30, 1996 (Biotechnology Industry Organization's Special Supplement): S1–7.
[6] Nichols, "Scientific Management at Merck."