

Many face of biotechnology



Area Development Site and Facility Planning

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Dolly who? That famous bioengineered sheep, no longer "hot news," is also no longer needed to prove biotechnology is one of the most amazing industries on the planet. That's because in today's scientific environment astonishing discoveries - or announcements of their imminent arrival - are made on a regular basis by biotech firms worldwide.

This young, extremely diverse field is booming. Beyond Borders 2002, Ernst & Young's first and latest report on the state of the industry, asserts at least 4,300 biotechs exist globally. Its data show that in 2001 alone some 600 public companies produced \$35 billion in revenues, spent \$16 billion on R&D, and employed approximately 188,000 workers.

Specifically, in the United States strong growth is indicated by the 2001 R&D expenses - \$15.6 billion - collectively paid for by more than 1,460 American biotechs. That same year investors blasted \$11 billion into the industry, up from \$3 billion in 1993.

Another sign of health: In the United States, the number of approved biotech drugs and vaccines grew sixfold from 1993 to year-end 2000, according to the Washington, D.C.-based Biotechnology Industry Organization (BIO). BIO counts as members more than 1,000 companies, academic institutions, and biotech centers from almost three dozen nations and is a growth association itself. Its members create products for the healthcare, agricultural, industrial, and environmental biotechnology sectors.

Before Dolly the clone made her splashy debut, the remarkable advances made in biotechnology were relatively unknown by the general public. While that still may be true, today's industrialized world citizen wants to know more about how biotechnology will positively affect his health and welfare.

With that in mind, we present here brief profiles of numerous attention-grabbing

biotechnology projects in various stages of development. Who knows...Chances may be good that one of them will improve your quality of life or that of someone you care about in the near future.

Healthcare

Healthcare products/services are perhaps most associated with the term "biotechnology" (particularly pharmaceuticals). BIO estimates some 325 million people worldwide have been helped by more than 130 FDA-approved biotechnology drugs and vaccines. Of the biotech medicines on the market, 70 percent were approved in the last six years. The current biopharmaceuticals market is thought to be at least \$15 billion. Other areas in healthcare biotech encompass diagnostics (e.g., tests for home pregnancy and AIDS in the blood supply), regenerative medicine, and vaccines.

The new fields of genomics and proteomics are very promising, dynamic components of the healthcare sector. After news that the complete sequencing of the human genome had been achieved, the scientific community began intensively analyzing and interpreting genes (genomics) so biopharmaceuticals could start developing disease-trouncing drugs.

According to FierceBiotech, an industry newsletter, genomics firm Perlegen Sciences (Mountainview, Calif.) "helps drug companies quickly identify promising drug targets from volumes of human genome data. [Perlegen] is mapping 50 human genomes to identify unique genetic variations. Drug companies will use this information to create the first wave of genomics drugs."

Relatedly, the study of the half million proteins within human genes (proteomics) helps researchers better understand how disease-causing viruses and immune responses work. "Once identified and interpreted," explains FierceBiotech, ". . . scientists can actually create new proteins to attack the unhealthy proteins within our bodies."

Recently it's been learned that osteoporosis, obesity, asthma, heart disease, and cancer have an underlying genetic basis. Fortunately, it's also known that personalized, gene-based therapies and diagnostics expected to be developed in the near future could greatly reduce the number of deaths caused by such diseases.

In Salt Lake City, Utah, much of the R&D activity at Myriad Genomics focuses on discovering genes related to cancer and cardiovascular disease. The biopharmaceutical identifies disease-causing genes and their role in the human body via advanced bioinformatics techniques incorporating both genomic and proteomic

technologies. Myriad states it has established "strategic alliances" with industry giants such as Abbott, Bayer, DuPont, Eli Lilly, Hitachi, Pharmacia, Novartis, Oracle, Roche, Schering AG, Schering-Plough, and Syngenta.

San Antonio's biomedical field in is now the largest industry in this tourist-focused city, supporting about 100,000 jobs and posting an annual economic impact of \$8.1 billion. A major player here - the Southwest Foundation for Biomedical Research (SFBR) - conducts world-renowned biomedical research in genetics, organic chemistry, physiology and medicine, virology, and immunology (e.g., HIV, AIDS, hepatitis, RSV, and emerging viruses). SFBR operates the nation's only privately owned maximum containment "hot zone" laboratory requiring researchers to wear protective "space suits." This Biosafety Level 4 facility supports research on Herpes B as well as fever viruses such as Lassa Fever, Ebola, Marburg, and Crimean-Congo Hemorrhagic Fever. Additionally, SFBR has the world's largest colony of baboons used for biomedical research. About 2,400 of its 3,800 primates help unlock the mystery of how genetics impacts the disease process.

August Krogh (1847-1949) said that "for every biomedical question, there is an animal with the answer." Wholeheartedly agreeing is Quebec's Nexia Biotechnologies, the first company to figure out - thanks to goats - how to reproduce spider silk in large commercial quantities. Why spider silk? It's a unique material highly valued for its strength, lightness, and flexibility by scientists. Nexia's key product, BioSteel, is recombinant spider silk protein spun into fibers after its extraction from the milk of transgenic goats. (Transgenic means they were given an artificially inserted gene.) Medical device applications of BioSteel could include wound closure systems (microsutures, surgical meshes, artificial ligaments), while industrial applications may include consumer biodegradable fishing line, tennis strings, and military applications (soft body armor).

Bioinformatics combines biology, mathematics, and computer science to figure out how to analyze the vast amount of data about biology now available. This field is revolutionizing pharmaceutical research beyond many researchers' wildest dreams, assisting with genetic sequencing, protein modeling, and drug simulation (determining how drugs work/interact without doing actual testing). Merck subsidiary Rosetta Inpharmatics (Kirkland, Wash.) is a well-known industry player, producing bioinformatics equipment and software used to analyze genetic data to identify gene functions and drug targets.

Stem cells anchor the new bioscience of "regenerative medicine." Because these "shape shifting" cells can change into other types of cells (i.e., muscle, bone, cartilage), scientists are exploring ways to use them to regenerate/restore bodies

ravaged by diseases such as cancer, diabetes, leukemia, and Alzheimer's. However, a worldwide ethical debate is raging because to retrieve these cells a few-days-old embryo must be destroyed. That means such research is totally unacceptable to individuals who recognize an embryo as a human being. Fortunately incredible medical breakthroughs have been made without embryonic cells (i.e., using umbilical and adult stem cells), thus supporting a more civilized, humane exploration of the science. Cord Blood Registry (Tucson, Ariz.) is the world leader in cord blood stem cell banking caring for the "spare immune system" of more than 45,000 people.

Agricultural

According to the Council for Biotechnology Information, 73 varieties of biotech crops are approved for human or animal consumption in North America. But agricultural biotech involves much more than creating genetically modified food. R&D in this sector is also designed to improve feed, food, and fiber; decrease chemical pesticide usage; increase bio-based production of energy, chemicals, and materials from a renewable source - even create transgenic, vegetation-based pharmaceuticals.

Alltech, a multinational biotech firm with core technologies in natural biotechnology and fermentation, recently completed a unique agricultural project in its home state of Kentucky. A "biorefinery" (Alltech's first) and an R&D center are major components of the firm's new 85,000-square-foot facility in Springfield. Based on diversification, a biorefinery is capable of producing a multitude of products from a multitude of natural resources. This means many different crops and byproducts from the agricultural and forestry industries can be processed into higher value products. Corn, wheat, and other cereal grains, for example, can be made into soy-based diesel, ethanol, and other commodities, reducing dependency on foreign petroleum products.

The very young but promising science of molecular farming uses plants to create an entirely different product from the plant itself. For example, researchers at Ontario's University of Guelph are transgenically altering the alfalfa plant and "tricking" it into producing a pig protein that could improve pig intestinal health. Many scientists believe both animal and human health will someday be improved with molecular-farmed medicines produced in tobacco, corn, soybeans, and other plants. Early-stage firm Plantigen (London, Ontario) expects its molecular farming efforts to yield therapeutic treatments for diabetes, multiple sclerosis, rheumatoid arthritis, and inflammatory bowel disease.

Industrial

BIO reports that industrial biotechnology applications "have led to cleaner processes that produce less waste and use less energy and water in such industrial sectors as chemicals, pulp and paper, textiles, food, energy, and metals and minerals." In fact, says the industry group, the majority of laundry detergents produced in America now contain biotechnology-based enzymes.

Some day soon upholstery, carpet, bedding, and mattresses may be made from PLA, the world's first and only performance plastic made from corn and other plants. Developed by Cargill Dow (Minnetonka, Minn.), it's already used to make such products as food containers, beverage cups, films, wraps, clothes, and golf balls. Environmentalists especially may take an interest in this unique plant-sugar substance. That's because Cargill Dow's process for making PLA requires 20 to 50 percent less fossil fuel resources than the typical synthetic fiber manufacturing process, and puts out significantly lower carbon dioxide emissions. A bonus: The firm says PLA products perform as well or better than similar products made from synthetic materials derived from oil.

The world's largest manufacturer of enzymes, Novozymes, calls them the "natural solution" to industrial problems. Why? They reduce the consumption of water, energy, and harmful chemicals while still making production more efficient. This Denmark-based firm produces and sells more than 500 enzyme products in 130 countries and has introduced almost every new industrial enzyme on the market. Novozymes' environmental applications are used in the waste-water treatment, bioremediation, institutional, household, and agriculture markets. Genencor International (Palo Alto, Calif.), another global leader in enzyme production, recorded revenues of \$350 million last year. It provides biotech solutions to the industrial-chemical, agri-processing, consumer, and healthcare industries.

Diversa "collects and catalogs the DNA of organisms in diverse environments (from manure piles to tropical Bermuda)...to develop new enzymes and other active biological compounds," states a Hoovers Online report about this San Diego-based firm. "A variety of manufacturers license these compounds from the firm to develop or improve their products, which include detergents, oils, animal feeds, and pharmaceuticals. Diversa's products include enzymes for the oil and gas industry." Partners include Dow Chemical, Syngenta, Celera, and a unit of Aventis.

Bioenergy (power from plants) continues to be the focus of intense R&D activity designed to find inexpensive, reliable, alternative energy sources and replace America's dependence on environmentally unfriendly fossil fuels. This research is particularly important in times of global unrest, when the nation's immense appetite for such fuels may or may not continue to be fed by foreign suppliers.

The U.S. Department of Energy (DOE) - and its National Biofuels Program in particular - seeks to cost-effectively produce ethanol and other fuels/chemicals from biomass resources such as agricultural and forestry residues, or quickly growing trees and grasses. Already much progress has been made developing biofuels such as ethanol (made from plant starch) and biodiesel (made from vegetable oil). Recently DOE's "Biomass Program" awarded about \$75 million to support multiple-organization biomass R&D involving Broin & Associates, Cargill, Cargill Dow, Dupont, High Plains Corp., and the National Corn Growers Association.

Environmental

Hazardous waste materials can be cleaned up more efficiently via the use of various environmental biotech products. Instead of relying upon dangerous chemicals to remove pollutants, for example, in some circumstances pollution-eating microbes have been used to do the job quite effectively.

Environmental systems company Envirogen (Lawrenceville, N.J.) is known for products that remove pollution from the air, water, and soil. Its biofilter systems offer a "safe, reliable, and cost-effective treatment of air pollutants," while providing a biotech-based alternative to standard thermal, chemical, and adsorptive processes. Envirogen also offers an "extensive collection of degradative bacteria" serving as a "unique and valuable tool" for biocatalysis (a process using microorganisms and/or enzymes to perform vital chemical reactions).

Then there's the Center for Environmental Biotechnology (CEB) at the University of Tennessee (Knoxville), which has been engaged in diverse and leading edge research in this growing biotech sector for 16 years. CEB's nanotechnologies division develops microtools for sensing, actuation, information extraction and processing, and computing at the molecular scale.

One of its new "nano" products, not yet commercialized, is the Bioluminescent Bioreporter Integrated Circuit (BBIC). This fingernail sized device is made up of genetically engineered, bioluminescent bacteria deposited on an integrated circuit to form special chemical sensing elements. What's the whizbang functionality? Allowing info sensed by cells on the circuit to be instantaneously processed and transmitted to another location. Two of the BBIC's numerous proposed uses include assessing groundwater contamination in deep underground chambers (simply drop it into the reservoir), or detecting/quantifying compounds from afar that could threaten a crew's safety on manned space missions.

Cleveland Biotech (England) grows naturally occurring bacteria to create products

for the degradation of organic wastes, including fats, oil and greases, cellulose, petroleum hydrocarbons, and chlorinated organics as well as for inorganics (ammonia, nitrite). Cleveland's commercial products help clients keep drain lines free-flowing and clear of foul odors, maintain good water quality in ponds, speed up the rate of composting, and offer other agricultural and land remediation benefits.

Special Applications

This biotechnology sector is expected to continue growing at a rapid clip as more uses are found for unique or unusual new discoveries not fitting into traditional biotech categories, but offering products just as vital to human health and happiness.

Homeland defense and national security issues are on the front burner of many biotech firms' agendas these days. In post-9/11 America numerous biotech firms are involved with defense projects - or developing technologies - for use in conventional health care and for defense against biological agents. Such products/platforms include vaccines, therapeutics, and diagnostics designed to fight bioterrorism in various ways.

INCELL Corp. (San Antonio) has developed an oral smallpox vaccine, and is raising \$10 million in capital to fund its production. "We believe...widespread use of this vaccine will remove the threat of smallpox as a weapon of mass destruction," says CEO Dr. Mary Pat Moyer. The firm intends to develop other oral vaccines for potential biodefense needs.

TV crime shows have showcased biotechnology for years in the form of DNA fingerprinting (or "typing"), which is also used to detect microorganisms, ascertain paternity, assist with anthropology, and help find new ways to save endangered species via captive breeding programs in zoos. A new DNA typing (PCR) speeds up the identification process and "amplifies" DNA with improved accuracy. It has even been used to detect genes that may indicate a predisposition to certain diseases.

Investigen (Hercules, Calif.) sells "rapid" PCR-based tests that detect microorganisms and genetically modified organisms without relying on culturing or antibodies. Clients include those in the biodefense, food/water safety, industrial microbiology, and clinical diagnostics fields.

Biosensors - especially those delivering quick results - are a growth market in these troubling times. According to a recent study published by Business Communications Co., the total U.S. market for biosensors and bioelectronics reached \$1.32 billion in 2001. Growing at an annual average rate of 6.6 percent, the market is expected to exceed \$1.82 billion in 2006.

Additionally, around the world domestic animal health problems are being addressed via biotech solutions never before dreamed possible. Orchid BioSciences (Princeton, N.J.) is the leading provider of services/products for profiling genetic uniqueness (forensic and paternity DNA testing, pharmacogenetics-based personalized health care, etc.). In 2001 its Orchid BioSciences Europe business unit won the major portion of the largest commercial genotyping service contract awarded to date. This work consists of performing millions of SNP (single nucleotide polymorphisms) genotypes that will help guide selective breeding programs designed to eliminate the deadly mad cow-like disease Scrapie in sheep.

[Sidebar]

Various projects in this industry are having an important impact on healthcare, agriculture, industrial operations, the environment, and even homeland defense.

[Sidebar]

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Scientists are exploring ways to use stem cells to regenerate/ restore bodies ravaged by diseases.

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