

ent, no foreign company is taking part, but the laboratory has received numerous inquiries from foreign enterprises, and now that principles have been established for handling intellectual properties, foreign enterprises are expected to join in the near future. The research lab also accepts researchers from foreign uni-

versities and state research institutes, and has already decided to accept two American and one British researchers.

Japan's research and development work in basic technologies is becoming increasingly fundamental, long-term and international in nature. The day is fast approaching when Japan will be in a posi-

tion to make a big contribution to world prosperity in the 21st century. ■

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Rise of Biotechnology

By Satoshi Kusakabe

The industrial utilization of bacteria and plants is nothing new, dating back in some cases for hundreds of years. But there has been an explosion in new applications since the development of recombinant DNA technology in 1973. Today a high-tech biotechnology industry produces a whole spectrum of products, from pharmaceuticals and food to cosmetics, reagents and amino acids.

Japan's Ministry of International Trade and Industry has closely followed the rise of Japan's biotechnology industry. Since 1981 biotechnology has been a priority item on MITI's agenda. Now the ministry has drawn up a new policy that will help govern Japan's biotechnology efforts far into the future.

Taking root

Aside from traditional applications of fermentation technology and other embryonic biotechnology techniques, industrial biotechnological research and development work really began in Japan in the early 1980s. Many organizations and corporate research laboratories hopped onto the biotechnology bandwagon in these early days, generating wide-ranging basic research and leading to the first commercial biotechnology products.

MITI was well aware of these developments, and established a number of

policies to help the budding biotechnology industry take root in Japanese soil. Major MITI programs included the "Next-generation Industrial Infrastructure R&D" system, which launched projects into recombinant DNA and other areas of biotechnology in 1981. These early research projects proved a catalyst that stimulated independent R&D efforts throughout Japan.

As the technology itself took shape. MITI's policy focused on the more practical matter of establishing a viable Japanese bioindustry. In 1986, the ministry drew up industrialization guidelines for recombinant DNA technology that put in place the safety standards essential for building up industrial infrastructure in this new field. As a direct result of this ground-laying work, recombinant DNA technology began finding its way into people's daily lives in the form of detergents, cosmetics, amino acids, reagents, enzymes and other products.

By the autumn of 1986, Japan was ready for its first biotechnology fair. Held in Tokyo, the event provided an international forum for the exchange of information and ideas in this rapidly evolving field, and proved so successful that a number of Japanese industries established the Bioindustry Development Center (BIDEC) the following year. The nonprofit BIDEC promotes both international

exchange in biotechnology and supports the new industry.

Yet all that has been done so far is only a beginning compared with the full potential of this new industry. Since the turn of the year MITI has adopted a new strategy for biotechnology designed to position this increasingly growing technology and industry as a valuable part of Japanese society, compatible with both human beings and the environment.

In specific terms, this policy calls for ensuring that the broad range of biotechnology products now under development will contribute in a meaningful way to bettering the lives of the people. At the same time, the ministry is committed to furthering the exploration of this field, one of the last great frontiers left to mankind, through increased basic research. The new policy was formulated, moreover, with an awareness of the need for Japan to contribute more to international society and to preserving the global environment.

Today environmental problems—be they pollution on a global scale or waste materials crossing national borders—are being seen from a new perspective that has cast new light on industrial activity and its impact on the global environment. Values are changing at the private sector level, not in the sense of abandoning such old values as efficiency and convenience,

but rather factoring in new concerns; the renewability of raw materials, the use of production processes that are less harmful to the environment and less liable to cause pollution, post-use biodegradability and the compatibility of products with the human body and natural environment.

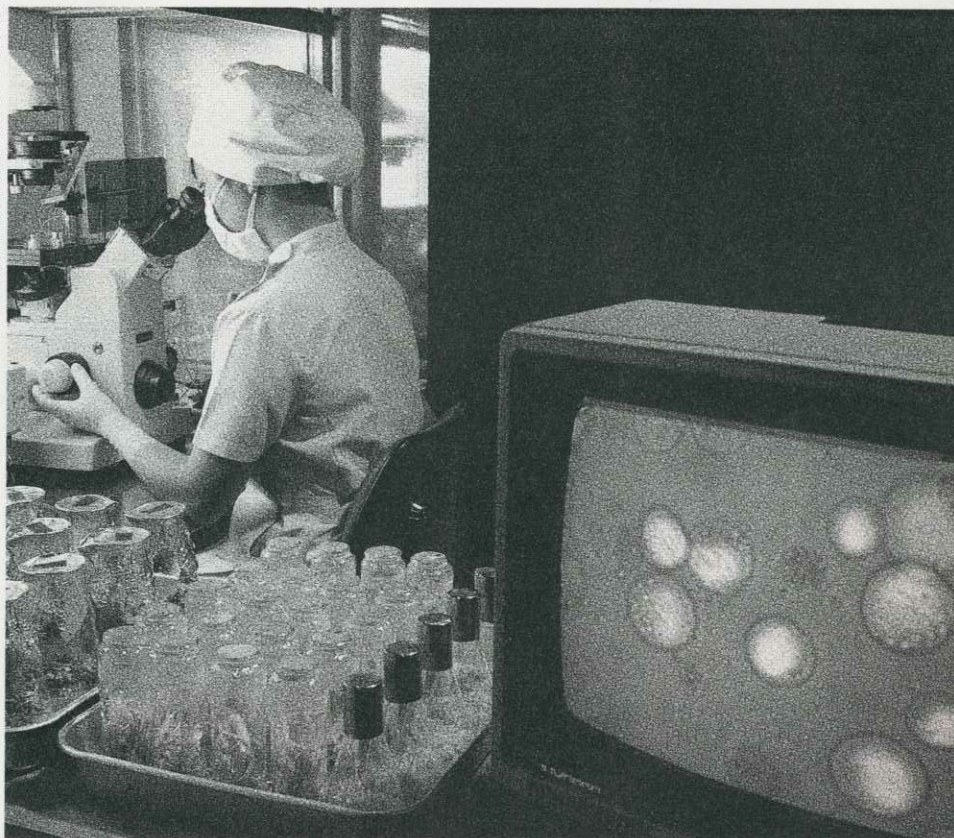
Age of awareness

The products of biotechnology have an inherent advantage in this age of new awareness. The bioindustry uses renewable feedstocks, such as natural vegetable oils for detergents, while biological processes can be used under mild rather than extreme conditions in the production process. Already acrylamide is being produced using bioreactor technology, to take one example. Biotechnology R&D, meanwhile, also generates data about the interaction between substances and the human body, knowledge that has already paid off in more healthful cosmetics and products. And finally, the natural raw materials used in bioindustry products ensures that they are degradable, minimizing environmental problems. New compact detergents using enzymes are only one of many examples. The bioindustry is in tune with new social values.

At present, various types of industrial bio-products are being produced annually, excluding pharmaceuticals and food products. These goods have several things in common; they have been developed by learning from life itself, utilizing life, and contributing to life. MITI's new policy also reflects the rising demand for technology, products and industrial systems that are not harmful to either human beings or their environment. It is intended specifically to promote these healthy values. At the same time, MITI intends to promote second-generation biotechnology research programs, encourage the geographical diffusion of the bioindustry itself, improve safety standards and expand Japan's international cooperation in this important field.

There are four parts to MITI's new bioindustry policy. First, the ministry will cooperate in unifying international safety standards. Proper safety measures are in-

Photo: Mitsui Petrochemical Industries



dispensable for industrializing a new technology. With public concern over the safety of this new technology on the rise worldwide, the establishment of international standards has become a task of pressing importance.

In April 1988 the Organization for Economic Cooperation and Development (OECD) again took up the discussion of safety measures for industrial biotechnology applications after a hiatus. Japan, for its part, is ready to contribute its skills and knowledge to the OECD effort. Japanese areas of expertise include brewing and fermentation, which date far back in Japanese history. More recently, between June 1986 and December 1988, the Japanese government has reviewed safety arrangements for 133 industrial production plants in light of its recombinant DNA industrialization guidelines. The insights gained from these examinations will be shared with the OECD, both to aid the creation of international inspection standards and to gain public acceptance of biotechnology. Some ¥150 million has

been budgeted for MITI's efforts in international standard-setting.

The second arena is R&D. Japan's first-generation R&D in biotechnology was largely designed to confirm the results in recombinant DNA and other fields. Today, however, Japan is ready to develop its own original technology, and to do original work in utilizing the multiple functions of biological substances. What Japanese scientists have dubbed "second-generation" R&D programs are aimed at pushing forward the frontiers of biotechnology, including oceanic studies and research into protein conglomeration. One Japanese marine biotechnology center, called the Research Center for the Industrial Utilization of Marine Organisms, has been founded for marine research, while a 10-year protein conglomeration project is slated to begin in 1989.

MITI will also launch feasibility studies on highly biodegradable plastics, a subject of keen interest in the U.S. and European nations, during fiscal 1989.

A third area of international activity



Biotechnology applications in many different fields were displayed at the Bio Exhibition Symposium Tokyo '88.




under the new MITI biotechnology policy is cooperation with developing nations. These countries are blessed with rich solar energy and biological resources, making them well equipped to cash in on biotechnology. MITI has already helped Malaysia develop vitamin E, and beginning in fiscal 1989 will be assisting a project to utilize the useful ingredients of eucalyptus. Some governmental official development aid has been earmarked for the study. The aid project is expected to continue for over five years.

In the mainstream

The fourth area of bioindustry policy envisaged by MITI is for Japan to continue to promote forums for the international exchange of information and ideas. The new biotechnology policy commits MITI to actively promoting bilateral industrial cooperation in this field, while encouraging international exchange through symposia and exhibitions. BIDECE, which held a highly successful biotechnology fair in Tokyo in October 1988, will continue to serve as

the administrative arm for such international events. The last fair drew more than 60,000 participants, including 198 people from 26 foreign countries.

MITI is clearly gearing up for a future in which biotechnology will be even more important than it is today. The ministry's present Bioindustry Office will be upgraded in fiscal 1989, with the name of the new section tentatively set as the Bioindustry Division. This expanded office will coordinate the ministry's new biotechnology policy.

MITI intends to implement even more new policies in this important area in the future. The ministry feels that the establishment of a healthy biotechnology industry infused with new values could be the catalyst for bringing this promising new industry into the mainstream of Japanese and global society. 

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Bioindustry Chronology

Beginnings

- 1972 P. S. Carlsen of Britain develops cell fusion technology.
- 1973 Stanley N. Cohen and Harvard W. Boyer of the U.S. develop recombinant deoxyribonucleic acid (rDNA) technology.
- 1980 MITI organizes its Biomass Office to launch various biomass projects.

Early Stages

<R&D stage>

- 1981 Biotechnology research—rDNA, bioreactors and cell mass culture—begins, following creation by MITI of R&D Project on Basic Technologies for Future Industries.
- 1982 MITI creates Bioindustry Office.
- <Industrialization stage>
- 1986 MITI announces rDNA industrial utilization guidelines.
- 1986 First Tokyo International Bio Fair

Development Period

- 1987 Bioindustry Development Center (BIDECE) organized.
- 1987 Japan proposes the Human Frontier Science Program at the Venice summit.
- 1988 OECD resumes discussion on bioindustry safety measures.
- 1988 Toronto summit discusses global environmental issues.
- 1988 Second Tokyo Bio Fair
- 1989 MITI to form Bioindustry Division (name subject to change). MITI projects will include:
 - formal start of marine biotechnology R&D project;
 - second-generation R&D for protein conglomeration investigation/use;
 - feasibility studies on biodegradable plastics;
 - full-fledged start of the Human Frontier Science Program;
 - safety measure standards unification with OECD;
 - cooperation with developing countries on eucalyptus ingredients.