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Biotechnology

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YOUR GUIDE TO THE BIOTECHNOLOGY REVOLUTION

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BIOTECHNOLOGY

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A Promise to Heal, Fuel, and Feed the World

BY: JAMES C. GREENWOOD, BIOTECHNOLOGY INDUSTRY ORGANIZATION (BIO), PRESIDENT AND CEO

The innovative spirit that lies at the heart and soul of America's biotech companies can and will provide solutions to disease, hunger, pollution, and global warming.

The science of biotechnology isn't easy. Nature does not readily yield her secrets.

Still, every day in nearly every country on Earth our brilliant scientists decode a bit more of the language of life. The science continues to astonish and amaze.

There are today more than 250 biotechnology products and vaccines approved by the FDA, extending lives and providing new hope for patients living with conditions such as cancer and HIV/AIDS. More than 600 new biotechnology medicines are currently either in human clinical trials or under review by the FDA for diseases including cancer, Parkinson's disease, diabetes, Multiple Sclerosis and more than 100 other conditions. Many other potential treatments, vaccines, and diagnostics are in earlier phases of development.

Agricultural biotechnology companies already are developing biotech plants and trees that can resist the stresses of drought or flooding, biotech crops that are nutrient-enhanced and even allergen-free, and biotech oils that are more healthful and contain fewer saturated fats. Today a record 13.3 million farmers in 25 countries are using agricultural biotechnology to increase yields and sustainability.

A flurry of new biotech start-ups are developing a range of chemicals and plastics from renewable feedstocks, including algae. Other companies have hit milestones in producing cellulosic ethanol, achieving concentrations rivaling sugar alcohols.

While the promise is great, the road to biotech breakthroughs is always difficult. Researching and developing new biotechnology advances is a long, expensive and risky process. For example, the development of a new biotech medicine, on average, costs $1.2 billion over the course of 10 to 15 years from the time research begins until it receives FDA approval to reach patients.

The current financial environment has left many biotech companies unable to access the investment capital they need to continue work on promising advances. Many companies in need of immediate funds are finding the capital markets closed to them. This has led dozens of companies to shelve or delay promising projects, lay off workers, and, in some cases, close their doors.

Biotech innovation has always been a high-risk enterprise and always will be. But in the current economic climate, it is more important than ever for us to make sure that our public policy environment values and incentivizes innovation.

One way Congress can increase investor confidence is by completing its work on health care reform. Uncertainty about the final shape of health care reform has kept many cautious investors on the sidelines. By adopting an approach that lowers costs and increases access to quality health care while preserving incentives for innovation, Congress can provide the market with much needed clarity.

Enacting a sound regulatory pathway for biosimilars, sometimes erroneously referred to as "biogenerics", also will bring greater stability to the biotech sector. As of early November, the health reform bill passed in the House of Representatives and the bill pending in the Senate include provisions for a balanced pathway for the approval of biosimilars. Both versions strike an appropriate balance among ensuring patient safety, expanding competition, reducing costs, broadening access and providing necessary and fair incentives for continued biomedical innovation.

Finally, Congress must recognize that renewable energy should not be treated in the same manner as fossil fuels under any climate change cap and trade legislation or treaty. Congress should not penalize low-carbon biofuels, but instead should reward their production since they can help reduce the carbon footprint of the transportation sector.

While these legislative initiatives will improve the policy environment and strengthen the overall investment climate for the medical biotech sector, many companies need more direct and immediate relief.

The health care reform bill adopted by the Senate Finance Committee would bring that relief by creating a biomedical research tax credit. The proposal would reimburse small biotechnology companies for a portion of their therapeutic research and development activities, including hiring scientists and conducting clinical studies.

Together, these policy prescriptions can help provide the certainty biotech researchers, and their investors need to continue to develop and improve biotech breakthroughs; breakthroughs that provide the best chance we have to heal, feed and fuel this planet we share.

JAMES C. GREENWOOD

BIO represents more than 1,200 biotechnology companies, academic institutions, state biotechnology centers and related organizations across the United States and in more than 30 other nations. BIO members are involved in the research and development of innovative healthcare, agricultural, industrial and environmental biotechnology products. BIO also produces the annual BIO International Convention, the world's largest gathering of the biotechnology industry, along with industry-leading investor and partnering meetings held around the world.

The High Price of Big Ideas in Pharmaceuticals

BY: PATRICK GILMOUR

Once futuristic scenarios of gene therapy, cancer cures and pharmacogenomics (drugs optimized for a patient's genotype) are today looming as real medical possibilities.

Medical biotech—"red biotech"—provides huge opportunities for the advancement of medicine. But a major obstacle exists, one that is a thorny issue in the side of all modern pharmaceutical businesses: cost.

Pharmaceutical companies are often demonized for the high price they put on their products, but the process of bringing a drug to market is much longer and more expensive than many people realize. With R&D and clinical trials lasting up to ten years and requiring hundreds of people, the price of getting a drug to market can be anything up to $1 billion and, like elsewhere in business, profit is not guaranteed.

Biotech pharmaceutical companies are susceptible to these factors too. While the production overheads for bio-based research can actually be lower, biotech companies are often start-ups, and so the relative cost of production can seem astronomical. And with patents running out after 20 years, the possibility of not gaining significant ROI before generics become available is all too real.

In the fledgling biotech industry, one possible advantage of the protein-based, large-molecule drugs they produce is they are hard to copy precisely without the exact manufacturing process used to create the original. This raises concerns about the risks of biotech generics—biosimilars—and has instigated legislation in the E.U. and U.S. that may actually lengthen the effective patents on biotech drugs.

With global sales of advanced biotech drugs like Avastin reaching $5 billion in 2008. The future looks very healthy for this new sector. While investment horizons may seem like a high-stake gamble to the average investor, it should not prevent interested individuals and institutions from investing in biotechnology. While direct investment in biotech start ups from developmental and clinical stages can take years to produce returns, investing through commercial development firms, is a more strategic option. Through biotech development firms, one is able to invest capital indirectly toward the commercialization of biotech research, without a 10- to 20- year commitment.

Contract development companies offer investors better protection from the volatility of biotech firms, with as little as one to two years of commitment.

State Initiatives Help Biotechnology Thrive

BY: PATRICK GILMOUR

As biotech asserts itself as a major player in economic growth, states and regions across the United States are working to create environments that attract and retain a new breed of innovative companies. The experience of Pennsylvania, Massachusetts and New Jersey—all top biotech centers—suggests that local incentives and support really do foster business growth.

Pennsylvania has one of the country's oldest economic development programs assisting biotech, with Ben Franklin Technology Partners now in existence for over 25 years. More recently launched programs have included the billion dollar Greenhouse Fund to support growth in the life sciences through green technology research, and a Venture Capital fund boosted with $60 million from the state. Pennsylvania now ranks fourth among all states in bioscience academic research and development expenditure, and the state has become a powerhouse in the bio-pharmaceuticals industry.

Mickey Flynn, president of Pennsylvania Bio, the association representing Pennsylvania's biosciences community, explains: "[it's about] developing a cohesive community that unites the region's biotechnology, pharmaceutical, research, and financial strengths." With bioscience providing work for 77,413 employees in 2008, and an estimated $6 billion generated each year, the R.O.I. for both state and private investors is clear in terms of employment and potential profit.

Massachusetts state's economy shrank 1.7 percent between 2001 and 2007, yet the bio-pharmaceuticals industry grew 42.6 percent during roughly the same period. Currently, there are more than 430 biotech companies in the state employing nearly 46,000 individuals, and generating over $4 billion of in-state payroll.

In 2008, the Massachusetts Life Sciences Initiative was passed, providing a $1 billion investment in biotech and life sciences over a 10-year period. Tax incentives and loan programs for start-up biotech companies have also bolstered fledgling businesses.

But financial incentives are only part of the picture. "The lifeblood of the biotech industry is all around partnering and innovation," says Imran Nasrullah, CBO of the Massachusetts Biotechnology Council. His organization is therefore working to foster strategic alliances through creating programs such as MassCONNECT, Pharma Days, and Innovation Exchange.

Peter Adair, director of economic development in Massachusetts, is optimistic: "The fact that biotech is still having such a strong impact on the economy speaks to the potential the industry will have once these companies mature and become profitable."

New Jersey, the fifth largest biotechnology center in the United States, contains major facilities for 17 of the world's 20 largest pharmaceutical companies. The Garden State also boasts 240 biotechnology companies and nearly 150,000 employees working in the pharmaceutical industry.

"Biotech is doing a lot of cutting-edge research [in New Jersey] that will eventually be used by the pharmaceutical industry," says Caren Franzini, CEO of the New Jersey Economic Development Authority. Key initiatives are therefore in place to retain and boost the state's biotech industry, including a $60-million-a-year, net-operating-loss program for young biotech companies to sell their losses for cash to profitable companies located in the state. New Jersey also provides space for young biotech companies in one of three Technology Centers, as well as incubator space at state educational institutions. And, earlier this year, Garden State representatives met with delegates from Daegu, South Korea, who are set to build a $5.6 billion high-tech medical complex in New Jersey.

> "...more than 430 biotech companies in the state employing nearly 46,000 individuals..."

Diabetes: Drugs, Developments, and Dividends

BY: CAITLIN SHURE

Diabetes mellitus (DM) is a multifaceted disease, affecting at least 6 to 8 percent of Americans; it is also a disease that requires constant self-monitoring, which can severely interfere with the daily activities that most of us take for granted. Exacerbating the lifelong frustrations of individuals with DM proper are common comorbidities associated with the condition, including: cardiac dysfunction, diabetic peripheral neuropathy (DPNP), and even blindness.

Naturally, a disease of such high prevalence and severity creates an impetus for therapeutic industries to supply for the existing demand. Fortunately, this demand has led to advancements in the management of the condition, reducing adversity experienced by affected individuals. In addition to the billions of dollars in pharmaceutical profits associated with DM, Americans also spend a significant amount of money purchasing low-glucose foods marketed at diabetic individuals. Most recently, developments in the field of biotechnology have created the potential for a future shift in conventional management of DM, though it is too soon to predict how such a shift would affect profits of the aforementioned industries.

While many treatment strategies can be applied to both type 1 and type 2 DM, it is important to clarify disparities in the management of these subtypes: DM type 1 is almost universally treated with insulin therapy—this is not always the case for DM type 2. Patients requiring insulin generally receive the agent via injection; however, other routes of administration, including pumps, inhalation, and islet cell transplantation are beginning to receive increased attention.

Of course, compliance to an appropriate diet is the cornerstone DM treatment, and traditional therapy (insulin injection) is extremely beneficial to persons suffering from diabetes; however, recent innovations in biotechnology present a novel option for chronic sufferers who have previously received ineffective care, as well as newly diagnosed patients seeking to optimize treatment. On the horizon are several innovative approaches to achieving healthy levels of insulin. Though most of these methods are in preliminary stages of research (many still confined to animal models), they do offer promise for the future of diabetes care. For example, one study (Chen S, *et al*) utilized ultrasound targeted microbubble destruction to control plasmid delivery of genes effective in expressing insulin. If comparable therapies were to be mainstreamed, one wonders how existing pharmaceutical companies in the field might be affected, as the "insulin industry" depends on the client/patient utilizing daily treatment, whereas a patient choosing gene therapy, would either achieve indefinite benefit via one-time administration or, at least, require less frequent treatment.

As is true of the management of diabetes itself, current research in the treatment of DM comorbidities has been enhanced by the introduction of gene therapy. Preliminary studies suggest that this type of treatment could potentially have a role in alleviating coronary artery disease, hypertension, wounds related to diabetes, and neuropathy.

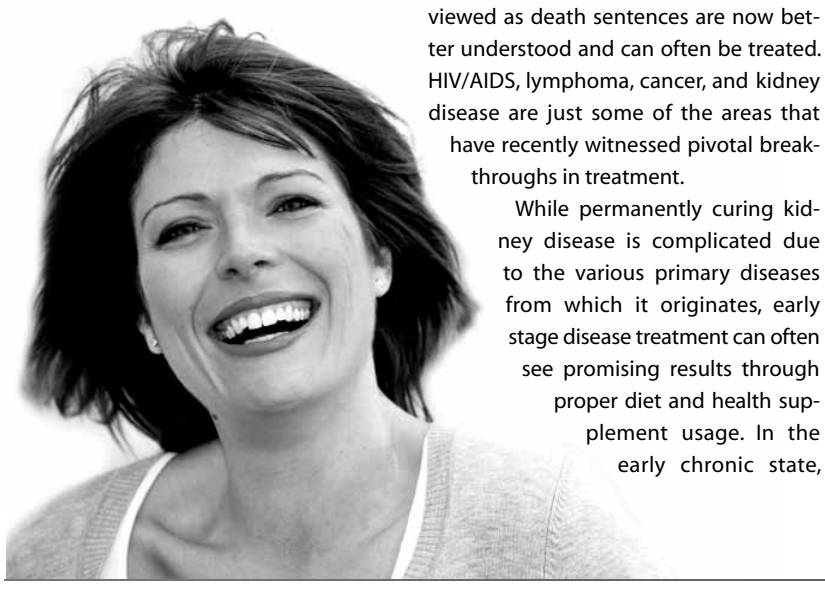
Ultimately, it becomes apparent that options for the management of diabetes can range from the irritatingly obvious ("eat well," "pick up jogging") to the conventional (insulin), all the way to the seemingly futuristic (gene manipulation). While potentially overwhelming, this multitude of choices should inspire optimism in the many individuals suffering from DM. Though there currently exists no "cure" for diabetes, it is clear that there are many promising opportunities to improve existing treatments and maintain hope for the arrival, someday, of a cure.

From Despair to Hope: Advancements in Medicine Through Biotechnology

The universal desire for good health has created a multi-billion dollar business in the United States with extraordinary results and a price tag to match. Patients suffering from chronic illnesses, such as non-terminal cancer or kidney disease, frequently accumulate huge financial burdens as a consequence of the various forms of treatment they receive. But if the price is high, the return on investment is immeasurable: certain illnesses once viewed as death sentences are now better understood and can often be treated. HIV/AIDS, lymphoma, cancer, and kidney disease are just some of the areas that have recently witnessed pivotal breakthroughs in treatment.

BY: PATRICK GILMOUR

Biotechnology research has led to new, cutting-edge and breakthrough approaches to treat a wide array of debilitating diseases. Developing biotech treatments and cures requires a long and risky process – it takes approximately $1.2 billion and twelve to fifteen years in development before a biotech medicine reaches the approval stage. The investment in research and development is high, but the return on investment is immeasurable: certain illnesses once viewed as death sentences are now better understood and can often be treated. HIV/AIDS, lymphoma, cancer, and kidney disease are just some of the areas that have recently witnessed pivotal breakthroughs in treatment.



While permanently curing kidney disease is complicated due to the various primary diseases from which it originates, early stage disease treatment can often see promising results through proper diet and health supplement usage. In the early chronic state, kidney disease manifests when an excessive amount of minerals such as sodium and magnesium form toxins in the body. Through recent biotech research, however, scientists have been able to manufacture probiotics that help to expel these toxins through the bowel, significantly improving many patients' quality of life. And the low price of such supplements means they can benefit poorer nations which find the high cost of traditional treatments prohibitive.

Biopharmaceutical research has also engendered a better understanding of how cancer forms and how it can be treated. From the difference between "liquid" (blood) and solid tumors, to the rate cancerous cells metastasize, the medical community now has a clearer idea of how cancer works. To quote Dr. Jeff Vaught—an expert in the field—on the subject of eradicating cancer cells: "As we learned how they lived, we learned how they died. We began to learn about survival mechanisms and thought, maybe we can translate this into oncology, and intercept these survival mechanisms and cause cell death."

Over the last 30 years, this new knowledge has translated into 25 biopharmaceuticals approved for the market. 16 are used for the direct treatment of cancer, while the remaining work to some degree in supportive care for treatment of side-effects. Today, through treatments typically involving a combination of surgery, radiation, and drug treatment, the future looks brighter for many cancer sufferers. Biotechnology, in particular, has advanced health-care in this area, with science and technology now able to create antibodies that are genetically programmed to target specific tumors. With the aid of potent toxins, this new generation of powerful medications can sometimes not only shrink but completely eradicate the cancerous cells from the body.

> "Biotechnology, in particular, has advanced health-care in this area, with science and technology..."

Through many years of painstaking clinical research and testing, the biopharmaceutical industry has steadily begun to revolutionize the treatment of chronic illnesses. While medical advances have not yet brought us to the stage of fully eradicating life-threatening illnesses like cancer and kidney disease, they have allowed us to move away from always considering certain illness as "terminal" with an exponential increase in the amount of patients now surviving once fatal illnesses.

The cost of biopharmaceutical progress, however, can be as astonishing as the results. The outlay for developing a cancer treating biopharmaceutical drug can exceed into the billions and there is never a full guarantee of success. For those successful compounds that ultimately become a brand name prescription, however, the possibilities seem almost endless both in terms of the financial benefits they reap and the people they help.

Succinic Acid

BY: PATRICK GILMOUR

Since the beginning of the industrial revolution, manufacturing processes have invaded the natural world. Now, in a fascinating inversion of the trend, the organic world is invading manufacturing.

Biotech is not just about biofuels and medical research. A growing number of "white technologies"—industrial uses for biotech—are creating big changes in the manufacturing sector. The technology is bio-based and, if the industry experts are right, the products may prove better and cheaper than their current petrochemical counterparts.

Succinic acid is one such chemical product. In August 2004, the U.S. Department of Energy (DOE) identified succinic acid as one in a top twelve of priority chemicals, due to their technological feasibility, size of their potential market, and interest to the chemical industry. The race was soon on to produce succinic acid using biotech.

Historically known as "spirit of amber'" succinic acid was traditionally obtained from ground amber and used medicinally. More recently, it has been derived from petrochemicals for diverse uses in the manufacturing of different plastic and polymer-based products.

Today, bio-based succinic acid from wheat or corn can produce exactly the same chemical as is derived from petrochemicals. And the price of production bucks the perceived trend of expensive green manufacturing processes. Bio-based succinic acid can already be produced for less than a dollar per pound—cheaper even than its Chinese counterpart produced from petrochemicals. Even better, the bio-based product is highly pure and not subject to the distribution problems that have sometimes affected imported supplies.

As a result, many products are already in production using bio-based succinic acid. They range from dashboards, side panels and other renewable car parts, to water bottles, the soles of running shoes, computer parts, PVC piping and other plastics. It has even been used to produce less corrosive and environmentally damaging forms of de-icing chemicals for runways, leading to significant reductions in the cost of servicing airplane braking systems.

Bio-based succinic acid is not only cheaper, it provides environmental advantages too. The manufacturing process is cleaner, producing less toxic waste, and because the base chemical product has not changed, manufacturers don't need to retool to build their products. And there's good news too on CO2 emissions. The anaerobic fermentation in bio-based production actually consumes CO2. Industry players claim that building one 25,000m2 bio-based production plant is the equivalent to taking 8000 cars off the road every year.

With so much environmental and economic potential, bio-based succinic acid is spawning a new generation of tech start-ups with many big players already investing or waiting for the right time to buy up the leading-edge technologies as they emerge.

Yet, for all the potential and interest in white technologies, the U.S government has been slow to offer the same preferential loans to idea-based development as it does for more traditional manufacturing requirements like plant construction. Government backed loans in European countries have even led some US-based companies to build plants abroad while they await the outcome of the Obama administration's energy bill, expected later this year.

Biotech promises to bring sustainable and renewable products with a low environmental impact that generate whole new areas of business. To what extent the industry grows in the future, however, depends not only on great ideas, but savvy investments and political will too.

Biofuels [Ethanol, Biobutanol]

BY: PATRICK GILMOUR

The first mass production automobile—the Ford Model T—was capable of running on ethanol until government legislation made this impractical. Cars of the future, with the return of a little good will from government, may run on a bio-based sibling to ethanol: biobutanol.

Biofuels—fuels extracted from organic matter—have been big news for some time, and they're set to become big business. With ever-rising oil prices and security issues disrupting oil supplies, many governments are keen to gain greater energy independence by producing alternative sources at home. At the same time, biofuels promise to reduce CO2 emissions, a necessary step in the fight against global warming.

In 2008, biofuels accounted for 1.8 percent of world transport fuel and the trend points to future high growth. Government is providing part of the incentive. The Energy Independence and Security Act of 2007 in the U.S. requires the country to be using 36 billion gallons or renewable fuel by 2022, 21 billion gallons of which must be "obtained from cellulosic ethanol and other advanced biofuels."

Given the controversy biofuels have caused in recent years, this might seem like government courting a major P.R. disaster. Few people outside the industry, however, realize that there are already three generations of biofuels and that significant breakthroughs are happening all the time. Referring to the Energy Independence and Security Act, industry watcher Andy Obermueller explains, "The rub is that only 15 billion gallons can be regular corn-based ethanol. 21 billion gallons—or almost 60 percent—must be "advanced biofuels" that are 50 percent cleaner than gasoline. Of that total, 16 billion gallons must be something called "cellulosic" biofuel."

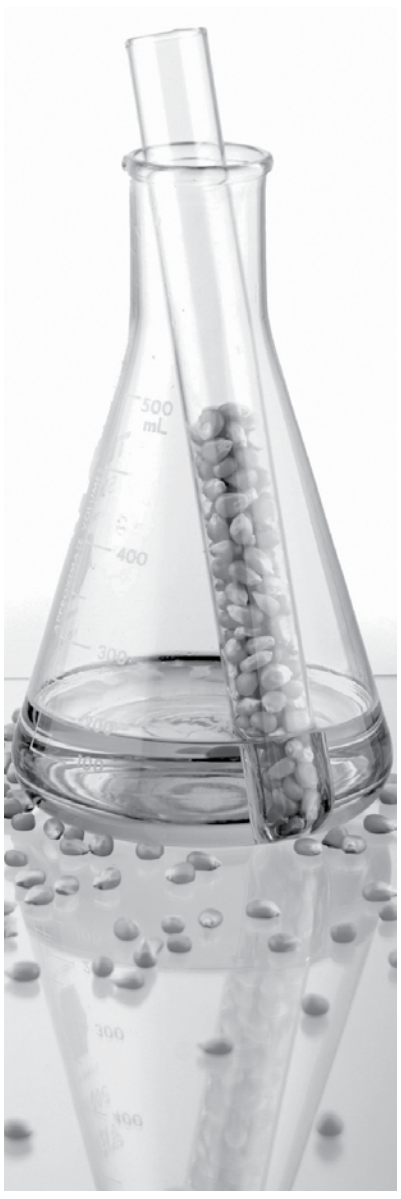
First generation biofuels are making strides in efficiency and using cleaner sources of inputs, such as biomass. New biofuels such as biobutanol—a heavier alcohol molecule that has more in common with gasoline than ethanol—are making an appearance.

Second and third generation biofuels—more commonly derived from specially grown high-energy yielding crops, waste or other non-food based products—are becoming more feasible and are receiving the endorsement of key political figures once opposed to biofuels.

Many in the industry claim the tools for creating biofuels are already here and the goal now must be to convert biomass into energy more efficiently. Evoking Moore's law of semi-conductors, industry expert, Mark Emalfarb, is sanguine that the technology will continue to improve: "There is no theoretical limit […] with biochemistry you can continue to ramp up the efficiency—that's the rate at which you can convert the biomass—and the productivity of how much you can make."

This generally means creating crops with a higher usable cellulose yield then refining the techniques for unleashing sugars that can be fermented into ethanol. But in new developments, some third generation technologies such as heliocultur and those using algae even fast-track the production of biofuels by producing usable fuels directly.

So the heavyweight struggle—Biofuels vs Oil—is on, and many see the outcome as a foregone conclusion. Biofuels are renewable, oil is finite. Biofuels will win and those who bet on the technologies that make this possible stand to make a fortune. Even if the industry, hard-hit by the credit crisis, fails to reach Congress's quotas, the need for a reliable and sustainable supply of fuel that is environmentally friendly promises a bright future for home-grown energy.



> "Biofuels are renewable, oil is finite. Biofuels will win."

Absolute Match: DNA Testing for Absolute Confidence

Erroneous switching of patient specimens is an avoidable problem that may occur at any step of the workflow process in pathology. Regardless of when or where the error occurs, the potential for patient harm is high, particularly for patients who receive potentially irreversible treatment (or lack thereof) as a result.

To prevent these errors, Fairfax Identity Laboratories™, a division of AIBioTech™, now offers DNA testing under the brand name "Absolute Match™." This service compares DNA collected from the patient at the time of their procedure (via cheek swab) with DNA from the biopsy tissue to ensure that the diagnosis the patient receives is their own. The swabs are verified by the patient at time of collection and sealed in a tamper-proof bag. The result is absolute confidence that the diagnosis a patient receives is their own.

5 million lb/yr plant in Pomacle, France