and a liposomal encapsulation for small-molecule cancer drug Navelbine (vinorelbine) (also a generic). Company president George Yeh says that this is the largest investment in Taiwanese biotech history.

Laxer restrictions for public companies have also played a role. There are now some 30 companies taking advantage of new regulations, half of them in the biotech sector, says Lee.

Other regulatory changes have also been critical. In 2007, Taiwan enacted the Biotech and New Pharmaceutical Development Act, Taiwan's version of the Bayh-Dole Act, which allowed researchers at publicly funded institutes like the Academia Sinica in Taipei to collaborate with and serve as consultants or board members for private companies. It also gave tax breaks to biotech companies for research and training expenses. The new regulations gave a boost to a variety of companies, including TaiMed Biologics of Taipei, which was established the same year, says Chi Huey Wong, president of the Academia Sinica. Wong, who was actively involved in drawing up the regulations, helped TaiMed obtain ibalizumab (formerly Tanox's TNX355), a monoclonal antibody that binds CD4 and prevents the virus from entering cells, from Genentech in S. San Francisco, California. Now the drug is being developed at TaiMed's US facilities and supported with $6.9 million from the Bill and Melinda Gates Foundation.

Wong's own research has profited from these new channels. His improved enzymatic synthesis of a carbohydrate-based vaccine for metastatic breast cancer, which makes the drug suitable for large-scale manufacture, was licensed to Taipei-based OBI Pharma. OBI-822 is a novel cancer immunotherapy composed of a breast cancer antigen Globo H linked to a protein carrier, now in phase 3 trials, buoyed by NT$1.5 billion ($49 million) in financing secured last October. The close connection between OBI and Academia Sinica led to other licensing agreements for a new-generation cancer vaccine with class switch to IgG and longer memory—and potential application in treating 16 cancers—also developed in Wong's laboratory.

Growing confidence based in a solid, supportive regulatory and funding infrastructure has lured investment into the field. YFY's Chang, who manages the $70-million Taiwan Global BioFund, has been watching early investments pay off. Chang says the firm faced hard times since its inception in 2005 until about 2009. But over the last year, Taiwanese biopharma collectively raised $1 billion, Chang estimates, and several companies in its portfolio have made it big. Along with Taiwan Liposome's deal last year, Taigen raised NT$1.1 billion ($36 million) in its January 2014 initial public offering, and TaiMed raised $50 million in April. And in March, on the back of disappointing results for Bayer's hepatocellular carcinoma drug, Nexavar (sorafenib), Taipei-based Medigen, left as the front-runner in the field with its phase 3 heparanese inhibitor, PI-88, watched its stock price shoot up by 125%, from NT$200 to NT$450 ($6.60–14.90).

Chang says that biotech is proving attractive to nontraditional investors, including corporate funds from various industries such as banking and real estate. "We have entered a stage where participation has expanded and we have plenty of capital," says Chang.

The focus on emerging companies sets Taiwan apart from Singapore, the other Asian tiger that has fought to create a biomedical research base. Compared to Singapore, "with its strong push towards attracting multinationals, Taiwan has focused on smaller biotechs," says Carl Firth, CEO of Singapore-based Aslan Pharmaceuticals, which recently set up a subsidiary in Taipei. But the dearth of large pharma companies is a major weak point, says Academia Sinica's Wong. "We need to put more effort in recruiting big pharma to establish R&D centers in Taiwan," says Wong, adding that tax incentives would help bring in long-term investment.

Taiwan's investment in clinical trial infrastructure has paid off. In 1998, Taiwan's move towards applying international standards in clinical research started with the establishment of the Center for Drug Evaluation, a nonprofit, which trained doctors in international standards.

Most big pharma have indeed chosen Taiwan to run clinical trials. National Taiwan University Hospital has set up clinical research agreements with Leverkusen, Germany–based Bayer, London-based GlaxoSmithKline and Novartis of Basel. In 2012, the hospital inked a partnership with Pfizer that will expand the NT$100 ($3.3) million that Pfizer Taiwan invests in clinical research each year. Currently there are 15 phase 1, 51 phase 2 and 26 phase 3 clinical trials in Taiwan. Five drugs that have had new drug applications approved in Taiwan or the US the last 2 years are entering the market. "This is a major accomplishment," says Wong.

The Taiwan market alone is too small to justify large investment in drug development. But with warming trade relations, China is a logical place to seek expansion. "It's a quasi-domestic market," says Lee. Taiwan "suddenly goes from a very small to a very large market."

Despite political tensions, strengthening

IN brief

DARPA redesign

The US Defense Advanced Research Projects Agency (DARPA) opened a new office in April uniting its biology, and related engineering and computer science research. The Biological Technologies Office (BTO), directed by neurologist and retired Army colonel Geoffrey Ling, inherited 23 existing research programs and on April 24 launched its first new one, involving prosthetics. Other areas of research include diagnostics for infectious diseases, synthetic biology, biological clocks, systems biology and a program to establish the lineage of genetic modifications to living organisms. The office's 2015 budget is around $250 million. The research programs and grant procedures will not change in their structure, wrote an agency spokesperson, though they will align with the office budget is around $250 million. Bringing the biology strands together under one of DARPA's seven offices should give the agency's leadership, "a better sense of how to make investments," says David Rejeski, director of the science and technology program at the Woodrow Wilson International Center for Scholars in Washington, DC, and a member of a DARPA external board of advisers. That, in turn, should enable the BTO to recruit competitive researchers working in its focus areas and help them win funding. "When you have an office dedicated to an area, [its director] is an advocate," in the scramble for the agency's $2.9 billion annual budget says Sharon Weinberger, a journalist and author of a forthcoming book on DARPA. Kit Parker, a bioengineer at Harvard University and previous DARPA grant winner says, "The neuro-social sciences and the mind-body axis are two areas where I suspect BTO will go." BTO is soliciting its first round of applications on a rolling basis through April 30, 2015. *Lucas Laursen*

IN their words

"What we now need is collaboration from biotechnology and industrial partners to turn these findings into a simple, rapid and affordable test for TB that can be used in hospitals worldwide." Michael Levin, of Imperial College London, whose group identified a gene expression pattern for diagnosing children with tuberculosis, a difficult diagnosis to make with conventional methods. (*GenomeWeb* 1 May 2014)