

# A BOOST FOR VACCINE RESEARCH

Tremendous strides have been made in eradicating infectious disease scourges such as smallpox and polio that once killed and crippled millions; still, about 15 million deaths—or about one third of all deaths annually—result from infectious diseases worldwide, according to the World Health Organization. Of those, nearly half involve children under the age of 5 years, predominantly in poorer countries. The ongoing hefty death toll, the pharmaceutical industry’s increasing interest in the research and development of vaccines, and plentiful funding from multiple sources all combine to provide a range of opportunities for postdocs and graduate students in vaccine research. The field is high growth and, perhaps more important, the fruits of this work promise to have a real impact on the health of the world’s population. **By Emma Hitt**

**A** recent estimate of the global vaccine business by Lehman Brothers predicts that the vaccine industry will grow at a rate of 18 percent a year to \$30 billion by 2011—significantly faster than the average of 4.4 percent for the pharmaceutical industry overall. “Today we see more opportunity than ever to be gained from investing in vaccine research,” says **Keith Gottesdiener**, vice president for vaccine and infectious disease clinical research with Merck. “The reasons for the growth of the industry include increased funding, from both governmental and private sources, as well as an increased scientific understanding of the immune system that will enable real breakthroughs in the field,” he says. And increased growth translates into a stronger job market with more opportunities (see “Expansive Opportunities”).

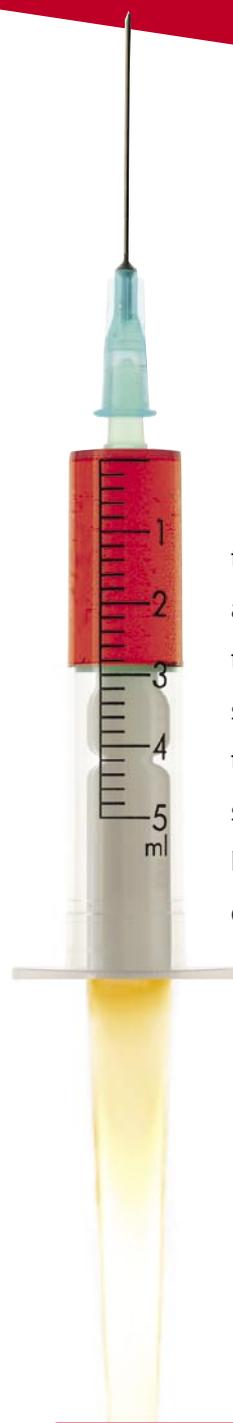
Recent blockbuster vaccines have included Gardasil and Cervarix, vaccines against certain human papillomavirus strains that cause cervical cancer, and Prevnar, the pneumococcal conjugate vaccine. Currently, about 20 vaccines are in development for HIV and are producing mixed results. The recent phase 2 STEP trial of the HIV vaccine (V520) showed disappointing results, but another vaccine made by GeoVax will be moving into phase 2 clinical trials in the next few months based on promising phase 1 results. VaxInnate is testing a universal flu vaccine that would work against all strains of the disease by using a Toll-like receptor (TLR) technology platform. Numerous experimental vaccines designed to ward off infections such as Japanese encephalitis virus, herpes simplex virus, and B cell lymphoma, and even to counter cocaine addiction, are under evaluation.

While vaccine research is clearly a growing field, this has not always been the case, notes **Alan Shaw**, CEO of VaxInnate, and the trend represents a stark contrast to the situation in the 1970s and 1980s, when many pharmaceutical companies exited the field due to poor economics and high risk of litigation. “A mere handful stayed in this business, but now, vaccines are seen as both economically and technologically interesting” he says. “A benefit of serving this area of research and participating in the development of a successful vaccine is that it is immensely satisfying. You can literally watch a disease disappear.”

**David Burt**, who runs R&D in GlaxoSmithKline’s North American hub, started working in the vaccine industry in 1989. “At the time, vaccines were thought of as being a low profit, low growth area but now pharmaceutical companies are viewing vaccines as a much more profitable area. New knowledge from the fields of immunology and microbiology has been applied to the development of vaccines in recent years. I think we have entered into a heyday for vaccines,” he says.

## Booster Shot for Funding

Increased funding has dramatically facilitated advances in the field within the past few years. To bring a vaccine through the R&D process to delivery can cost as much as \$500 million, and the probability that a preclinical vaccine candidate will fail to come to market is about five times higher than its likelihood of success, according to a World Health Organization **continued »**



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Careers in Product Companies (online only)—May 23

## Vaccine Research and Production

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(WHO) report. Since its inception in 2000, the Bill & Melinda Gates Foundation has contributed nearly \$8.5 billion to global health, with HIV and tuberculosis (TB) receiving \$2.29 billion and other infectious diseases about \$1.96 billion. In the United States, the budget of the NIH's National Institute of Allergy and Infectious Diseases (NIAID) is about \$4.5 billion for fiscal year 2008, and the WHO's Initiative for Vaccine Research budget was approximately \$26.5 million for 2006-2007. “Funding and commercial support are increasing in the area of vaccine R&D, especially because of the high investment by entities such as the NIH and the Bill & Melinda Gates Foundation,” noted **Marie-Paule Kieny**, director of the WHO's Initiative for Vaccine Research.

### Global Collaborations

Vaccine research presents many opportunities for those interested in traveling to the far reaches of the globe. The GAVI Alliance (formerly known as the Global Alliance for Vaccines and Immunization) has been in existence since 2000 and seeks to “align public and private resources in a global effort to create greater access to the benefits of immunization.” According to a 2008 UNICEF report, the Alliance's financial and programmatic support to vaccinate children around the world has helped prevent 2.9 million deaths since 2000 and decreased child mortality to less than 10 million per year for the first time ever.

“There has been a complete change in the attitudes of all involved in believing that vaccine coverage worldwide is possible and also that we can introduce and sustain that coverage in developing countries,” notes **Rosamund Lewis**, with the GAVI Alliance. Lewis points out that they have been able to make relatively new vaccines, such as the pneumococcal vaccine, sold in the West since 2003, available to developing countries. “So the time lag between vaccine licensing and vaccine introduction in developing countries has been reduced from 20 years to less than 10 years for other products [Hib and Pneumo vaccines for example].” Another example is the rotavirus vaccine, which was put on the market in the West just last year. “We are already introducing this vaccine to developing countries, so we have reduced the gap to two years, which is our aim. The other aim is to introduce vaccines that are of special interest to developing countries, such as a malaria vaccine,” she says.

The International Vaccine Institute, established under the Vienna Convention of 1969 with the signatures of 40 countries and the WHO, is headquartered in Seoul, South Korea. The IVI also focuses on bringing new vaccines to developing countries. According to **John Clemens**, the IVI's director-general, its immunology programs have focused on research and supply of vaccines against diarrheal diseases, bacterial meningitis and pneumonia, dengue fever, and Japanese encephalitis. “Our immunology program has a special interest in mucosal immunology and the development of improved clinical immunological tests that can be used in field evaluations in developing countries,” he says. “A particularly noteworthy accomplishment by the IVI has been the development of a sublingually administered vaccine which has demonstrated efficacy in eliciting mucosal immunity against respiratory and genital tract infections,” he notes.

### Online Resources

#### Industry:

**Crucell N.V.**  
[www.crucell.com/Careers](http://www.crucell.com/Careers)

**GlaxoSmithKline**  
[www.us.gsk.com/html/career/career-summer.html](http://www.us.gsk.com/html/career/career-summer.html)

**MedImmune**  
[www.medimmune.appone.com](http://www.medimmune.appone.com)

**Merck**  
[www.merck.com/careers](http://www.merck.com/careers)

**Novartis**  
[nibr.novartis.com/careers/internship](http://nibr.novartis.com/careers/internship)

**Sanofi-Pasteur**  
<http://www.sanofipasteur.com>

**Wyeth**  
[www.wyeth.com/careers](http://www.wyeth.com/careers)  
[pharmaresearch/university/postdoctoral](http://pharmaresearch/university/postdoctoral)

#### Government:

All job opportunities  
[jobsearch.usajobs.opm.gov](http://jobsearch.usajobs.opm.gov)

**Centers for Disease Control and Prevention (CDC)**  
[www.cdc.gov/employment/](http://www.cdc.gov/employment/)  
[www.cdc.gov/cogh/training/IETA](http://www.cdc.gov/cogh/training/IETA)

**National Institutes of Health/ National Institute of Allergy and Infectious Diseases**  
[www3.niaid.nih.gov/labs/training](http://www3.niaid.nih.gov/labs/training)

**National Institutes of Health Postdoctoral Opportunities**  
[www.training.nih.gov/student](http://www.training.nih.gov/student)

[www.training.nih.gov/webforms/postdoctoral/application/adIndex.aspx](http://www.training.nih.gov/webforms/postdoctoral/application/adIndex.aspx)

#### Global:

**European and Developing Countries Clinical Trials Partnership (EDCTP)**  
[www.edctp.org](http://www.edctp.org)

**The Global Fund to fight AIDS, Tuberculosis and Malaria**  
[www.theglobalfund.org/en/jobs](http://www.theglobalfund.org/en/jobs)

**US Agency for International Development (Washington, D.C.)**  
[www.usaid.gov/careers/applicant.html](http://www.usaid.gov/careers/applicant.html)

**World Health Organization (WHO)**  
[www.who.int/employment/en/](http://www.who.int/employment/en/)

According to Clemens, the IVI has a variety of programs and opportunities ranging from laboratory internships to pre- and postdoctoral student and fellowship opportunities. The institute also has shorter term training opportunities lasting a few months. The IVI has three divisions: the Division of Translational Research focuses on the treatment and prevention of pediatric dengue, Japanese encephalitis, respiratory pathogens, and rotavirus as well as “diseases of the most impoverished,” including typhoid fever, cholera, and shigella; the Division of Laboratory Sciences focuses on developing novel formulations and delivery systems for vaccines; and the Technical Assistance and Technology Transfer Program provides assistance in manufacturing practices and regulation in developing countries.

The Aeras Global TB Vaccine Foundation, a nonprofit product development partnership working in collaboration with private, government, industrial, and academic institutions, focuses on developing new vaccines against TB and ensuring their availability to all who need them globally. In September 2007, Aeras received a \$200 million grant from the Bill & Melinda Gates Foundation to accelerate TB vaccine development. “We seek to make TB vaccine regimens for infants and adolescents available and licensed in the next seven to nine years,” according to **Yasir Skeiky**, chief scientific officer of Aeras. “The disease of TB is probably worse than it was decades ago in terms of the health impact of drug resistant strains and coinfection with HIV,” he says, “and drug resistance is now extensive.”

According to Skeiky, Aeras's state-of-the-art manufacturing plant in Rockville, Maryland, can produce ~200 million doses per year of the recombinant bacille Calmette-Guerin (BCG) vaccine against TB, enough to meet global need. However, the BCG vaccine was developed 86 years ago, and TB, with increasing drug resistance, now kills more than 1.5 million people each year, second only to HIV/AIDS as the world's most

deadly infectious disease. Aeras's current pipeline includes six phase 1/2 vaccine candidates designed to combat multidrug-resistant (MDR) (resistant to first-line drugs) and extensively drug-resistant (XDR) TB (resistant to second-line drugs).

Lewis of GAVI points out that there is a need for people who can work toward enabling the delivery of vaccines to the people who need them. "Students interested in this area could enter into any number of fields in addition to immunology research, including public health, epidemiology, and health economics," she says.

### Needs and Emerging Challenges

Pressing needs in vaccine research will ensure opportunities in the field for years to come. "Obviously, we still have HIV, tuberculosis, and malaria staring us in the face," says VaxInnate's Shaw. "Most people in the industry would say that the easy vaccines have been developed already," he says.

"Understanding the host response will be a critical area in vaccine research," says **George Kemble**, vice president of research and development for MedImmune Vaccines, recently purchased by AstraZeneca. According to Kemble, many of today's vaccines were created by relying on the natural immune response mechanisms. "Our ability to control these reactions and use them to form a response to the vaccine will be critical in designing the next generation of vaccines," Kemble says.

Bioterrorism is another important and well-funded area in vaccine research. Concerns for national and international security have supplied impetus for an influx of funding for biodefense vaccines and emerging infection vaccines in the past five years. The Centers for Disease Control and Prevention in Atlanta, Georgia, is a pioneer of research on organisms such as anthrax, botulism, plague, smallpox, and viral hemorrhagic fevers.



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### Diverse Skill Sets

The need for skilled scientists at several levels is likely to increase in this field. "The field of vaccine research intersects with areas of public health, economics, politics, ethics, and patent/intellectual property issues. Opportunities exist for people with expertise including infectious diseases, epidemiology, molecular biology, immunology, and biostatistics," says **Eileen Barry**, with the Center for Vaccine Development at the University of Maryland in Baltimore.

Notably, the basic skills needed for vaccine research are taught in most universities: immunology, molecular biology, protein purification and analysis, epidemiology, biostatistics, biochemical engineering. "There will always be a need for people who have a strong background in basic science such as biology, chemistry, bacteriology, and immunology. Molecular biology and bioinformatics will be two of the areas in vaccine research with the strongest needs," says GSK's Burt.

So whatever your life science training, there could be a rewarding job for you in vaccine research. Exciting opportunities to travel and the ability to make a real difference to the health of humankind await.

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### Expansive Opportunities

A keyword search on "vaccine" at *Science Careers* ([www.sciencecareers.org](http://www.sciencecareers.org)) and other science job boards illustrates a range of diverse opportunities in vaccine research for which a Ph.D. is preferred or required. Here are sample job titles and the key responsibilities:

**Business Development Associate.** Identify and secure partners for products and technology developed by the company. Responsible for securing strategic product development and commercialization partnerships in the context of obtaining structured and long-term revenue to support and sustain R&D/commercial programs.

**Clinical Researcher.** Ensure that clinical trials are conducted in a timely manner and in accordance with regulations. In collaboration with the global clinical team, responsible for overall assessment, initiation, and management of vaccine clinical research investigators and sites.

**Director of Quality Assurance.** Ensure that vaccine and diagnostics distribution activities are performed in compliance with the good distribution practice requirements and function as the point of contact for companies performing distribution activities for vaccine products.

**Program Manager.** Manage programmatic, scientific, and administrative aspects of grants research programs at a vaccine research institute.

**Project Director.** Manage a large consortium of investigators in imaging (PET/CT) of animal models of tuberculosis, for the purpose of understanding current chemotherapy as well as development of new therapies.

**Pre- and Postdoctoral Opportunities in Biodefense and Emerging Infectious Diseases.** Undergo research training in biodefense and infectious disease. Area of research might include bacterial, fungal, parasitic, and viral pathogenesis, infectious disease epidemiology, molecular diagnostics, therapeutics and drug design, and vaccine development.

**Process Engineer.** Assist with technical development of vaccines by providing direct process support for the manufacture of vaccine products. Requires B.S./M.S. in chemical/mechanical engineering or the biological sciences fields.

**Regulatory Affairs Scientist.** Guides and implements the regulatory process for preclinical evaluation of HIV vaccine products leading to phase 1 IND submissions to the US Food and Drug Administration within the US Military HIV Research Program.

**Research Fellow, In Vivo Vaccine Research.** Responsible for providing creative inputs on vaccine development strategies, design and construction of live recombinant viruses, and subsequent characterization. Additional postdoctoral experience may be required.

**Research Specialist.** Research specific vaccines for the development and evaluation of novel vaccine delivery systems.

**Vaccine Formulation Development.** Formulates development activities of prophylactic and/or therapeutic vaccine products from phase 1 clinical trials through commercialization. The position will involve use of innovative and modern techniques to develop and characterize viable dosage forms with appropriate stability profiles of candidate molecules to meet project needs.

**Aeras Global TB Vaccine Foundation**  
[www.aeras.org](http://www.aeras.org)

**AstraZeneca**  
[www.astrazeneca.com](http://www.astrazeneca.com)

**GAVI Alliance**  
[www.gavialliance.org](http://www.gavialliance.org)

**GlaxoSmithKline**  
[www.gsk.com](http://www.gsk.com)

**International Vaccine Institute**  
[www.ivi.org](http://www.ivi.org)

**Merck**  
[www.merck.com](http://www.merck.com)

**University of Maryland Center for Vaccine Development**  
[www.medschool.umaryland.edu](http://www.medschool.umaryland.edu)

**VaxInnate**  
[www.vaxinnate.com](http://www.vaxinnate.com)

**World Health Organization**  
[www.who.int](http://www.who.int)