Table 1 Selected Zika vaccines in development

Developer (location)	Product
In trials	
GeneOne Life Science/Inovio (The Woodlands, Texas)	GLS5700 DNA vaccine containing pre-membrane and envelope protein
NIAID	VRC-ZKADNA085-00-VP
Sanofi	Purified inactivated virus vaccine
In preclinical development	
Immunovaccine (Halifax, Nova Scotia, Canada)	DepoVax-Zika vaccine Adjuvant plus antigen in liposome, suspended in oil
GeneOne Life Science	GLS5700 DNA vaccine containing pre-membrane and envelope protein
GeoVax Labs (Smyrna, Georgia)	GOVX-ZM01 modified vaccinia virus Ankara-virus-like particle vaccine
Replikins (Boston)	Trivalent vaccine for Zika, dengue and Japanese encephalitis
VBI Vaccines (Cambridge, Massachusetts)	Zika eVLP bivalent vaccine with E glycoprotein and NS1 glycoprotein
Moderna Therapeutics (Cambridge, Massachusetts)	Zika mRNA vaccine
Emergent BioSolutions (Gaithersberg, Maryland)	Zika vaccine using BARDA vaccine platform
Ennaid Therapeutics (Alpharetta, Georgia)	Zika vaccine with peptide fusion inhibitors
Hawaii Biotech (Honolulu, Hawaii)	Zika vaccine using recombinant proteins made in insect cell lines
Protein Sciences (Meriden, Connecticut)	Zika vaccine based on recombinant variants of E protein
VLP Therapeutics (Gaithersberg, Maryland)	Zika vaccine using i-alpha VLP technology
Valneva (Lyon, France)	VLA1601 inactivated Zika vaccine
Vaxart (S. San Francisco, California)	Non-replicating adenovirus type-5-vector-based Zika vaccine
Atheric Pharmaceutical (Troy, Virginia)	Repurposed marketed drugs
Bharat Biotech (Genome Valley, Hyderabad, India)	ZikaVAC inactivated virus ZikaVAC recombinant vaccine using viral surface antigens

BARDA, The Biomedical Advanced Research and Development Authority; eVLP, enveloped virus like particle. Source: BioMedTracker, clinicaltrials.gov, company websites

Tang at Florida State University in Tallahassee, who had a small NIH-funded program on dengue. In January, when his group was preparing to make a large batch of dengue virus, he switched gears immediately to Zika. Between then and now, his group, in collaboration with neuroscientists Hongjun Song and Guo-Li Ming at Johns Hopkins University in Baltimore, and Wei Zheng, at NIH's National Center for Advancing Translational Sciences (NCATS), published a series of papers relating to the virus's effects on neuronal cells (neural progenitor cells, astrocytes and brain organoids developed from induced pluripotent stem cells) (*Cell* **165**, 1238–1254, 2016). The team also identified small molecules that inhibit Zika virus replication from an NCATS repurposing library of 6,000 compounds (*Nat. Med.* **22**, 1101–1107, 2016). Their hits fall into two categories, inhibitors of Zika infection in human central nervous system cells and inhibitors of Zika-induced caspase activity, which causes neuronal cell death.

Tang and collaborators are moving forward, testing compounds that either protect neurons from Zika-virus-induced caspase or have antiviral activity. The team are "going deep and going broad," says Tang, gearing up to conduct preclinical studies with the repurposed drug Niclocide (niclosamide), approved by the US Food and Drug Administration for treating worm infections in humans and livestock, after they found it inhibited Zika replication in their screen. The researchers have also developed a specific assay for Zika replication, which they have used for rescreening the compound library (unpublished data). Tang has pieced together internal funding from his university with some external grants to support this work and, in August, a pharma holding company based in West Des Moines, Iowa, Spotlight Innovations, stepped in with several years of funding. The agreement gives the company the right to license any intellectual property that comes from the sponsorship.

Similarly, Barouch's team began work in early 2016 following reports about the epidemic in Brazil and the World Health Organization's declaring a global health emergency. With the help of three Brazilian post-docs working in his laboratory and their contacts, they were able to

Mutanome draws Genentech deal

Immunotherapy developer BioNTech of Mainz, Germany, has partnered with Roche's Genentech unit to develop, manufacture and commercialize novel mRNA-based, individualized cancer vaccines. The strategic collaboration combines S. San Francisco–based Genentech's cancer immunotherapy portfolio and research program with BioNTech's proprietary Individualized Vaccines Against Cancer (IVAC) clinical platform that uses next-generation sequencing of a patient's cancer genome to identify an array of unique mutations, known as the tumor 'mutanome', that potentially encodes for neoantigens. These neoantigens can be exploited by making an mRNA vaccine encoding selected neoantigens for each individual tumor's mutanome signature, triggering an immune response highly specific to the tumor. The approach could result in precisely targeted cell death in a broad range of cancers. "Unlike any medicine we have ever developed, virtually all cancer patients may potentially benefit from a custom built cancer vaccine," said James Sabry, senior vice president and global head of Genentech partnering. "By collaborating with BioNTech on this cutting edge approach, we hope to truly advance cancer treatments by using a common molecular backbone—mRNA—that is uniquely tailored to an individual patient." Genentech agreed to pay BioNTech $310 million in upfront and near-term milestone payments, and the two companies will share all development costs and any potential profits, with BioNTech retaining the right to co-promote certain products that arise from the agreement in the US, Germany and several other markets. The deal with Genentech follows previously announced collaborations with Bayer for new mRNA vaccines and therapeutics for animal health applications, and Sanofi for cancer immunotherapies.

"The disappearance of a few species, while a pity, does not bring a whole ecosystem crashing down." Evolutionary biologist Olivia Judson refers to attempts by the biotech company Oxitec to eliminate Zika-transmitting mosquitoes through engineering a fatal genetic trait into male *Aedes aegypti*. (*BloombergBusinessWeek*, 6 October 2016)

"I don't know what the precedent is for submitting three negative studies [to the FDA]." Phyllis Ferrell, vice president of Lilly's Alzheimer's division, speculates on the chances of approval for its Alzheimer's disease treatment, monoclonal anti-amyloid antibody (solanezumab), that has so far failed in clinical trials. (*STAT News*, 13 October 2016)