



# Vaccine Development: Innovating for the Future

APRIL 8, 2021

**U.S. Is In A Race Between Vaccines And Variants,  
Says Public Health Expert**

NPR, March 28, 2021

**Growing Concerns Over Spread of COVID-19 Virus Variants as  
Vaccine Rollout Continues**

NBC, March 29, 2021

**Coronavirus: 'Double mutant' Covid  
variant found in India**

BBC, March 25, 2021

**CDC director warns coronavirus variants could spark  
another avoidable surge**

CNN Health, March 19, 2021

**COVID-19 variants running rampant on Cape Cod**

Bangor News, March 29, 2021

**Florida COVID-19 variant cases  
surge in latest CDC numbers**

Local10, March 29, 2021

**Michigan, Minnesota see COVID-19 variant  
increases**

Center for Infectious Disease Research and Policy , March 29, 2021

# Agenda

- ▶ Welcome & Introductions
- ▶ Emerging Infectious Diseases & Vaccine Overview
- ▶ Vaccine Development: Past & Present
- ▶ COVID-19 Variants
- ▶ Innovations In Vaccine Development
- ▶ Rapid Vaccine Development with Self Assembling Vaccines
- ▶ How Can Congress Support Vaccine Development Innovations
- ▶ Q&A

# Panelists Introduction

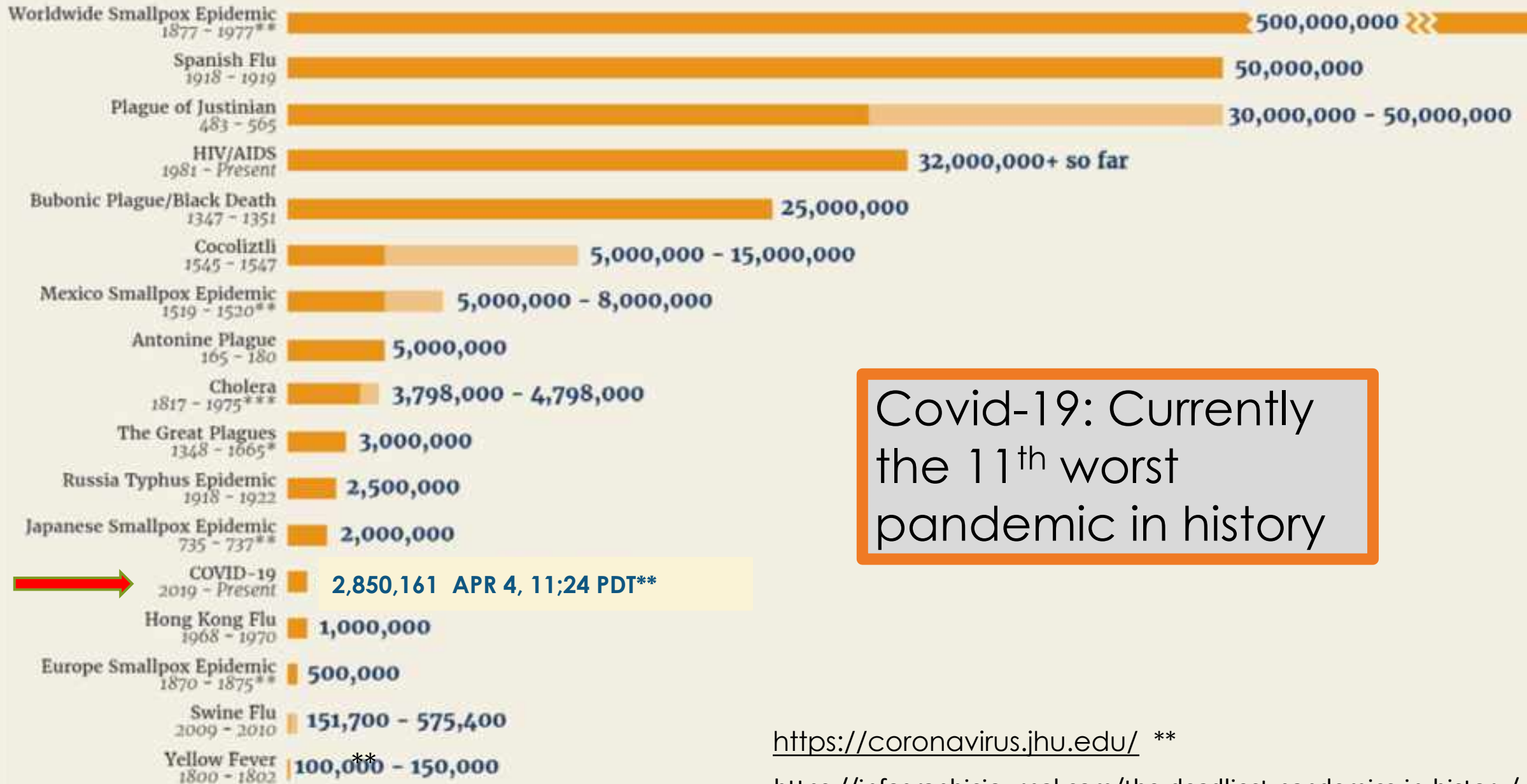
- ▶ **Michael V. Callahan, M.D, MSPH, DTM&H**, Division of Infectious Disease, Massachusetts General Hospital; Former COVID Advisor, ASPR;/HHS, Director, DARPA BioDefense , Special Advisor, OSTP/NSC Presidents Obama and Bush (2003-2012), Clinical Envoy, Nanjing and Wuhan University Hospital
- ▶ **Mark C. Poznansky, MD, PhD, FRCP, FIDSA**, Director Vaccine and Immunotherapy Center, MGH Research Scholar, Attending Physician Infectious Diseases Medicine, Massachusetts General Hospital/Associate Professor Harvard Medical School
- ▶ **Patrick M. Reeves, PhD**, Instructor in Investigation, Massachusetts General Hospital/Instructor Harvard Medical School



# Emerging Infectious Diseases & Vaccine Overview

MICHAEL V. CALLAHAN, M.D

# Global Pandemics by Death Toll



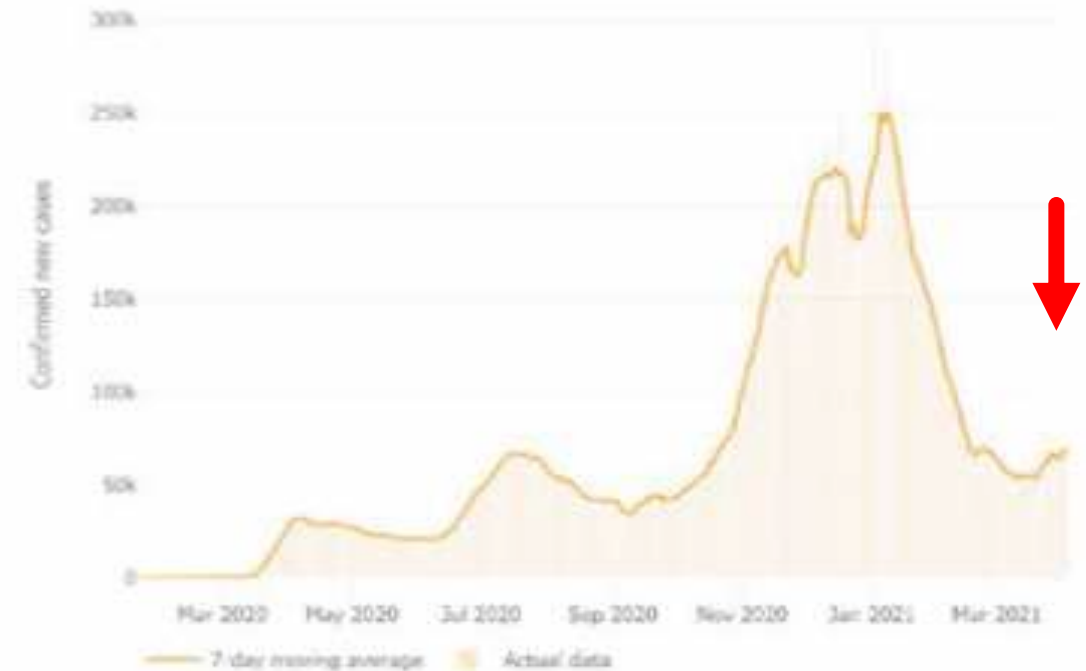
Covid-19: Currently the 11<sup>th</sup> worst pandemic in history

<https://coronavirus.jhu.edu/> \*\*

<https://infographicjournal.com/the-deadliest-pandemics-in-history/>

# Current Issue: Anatomy of the Spring Surge

- ▶ 19% increase in cases over last 12 days
- ▶ Common in states with reduced restrictions and lower vaccination
- ▶ Compounded by **rapid increase** of more-infectious variant strains (doubling time 10-14 days)



<https://coronavirus.jhu.edu/us-map>

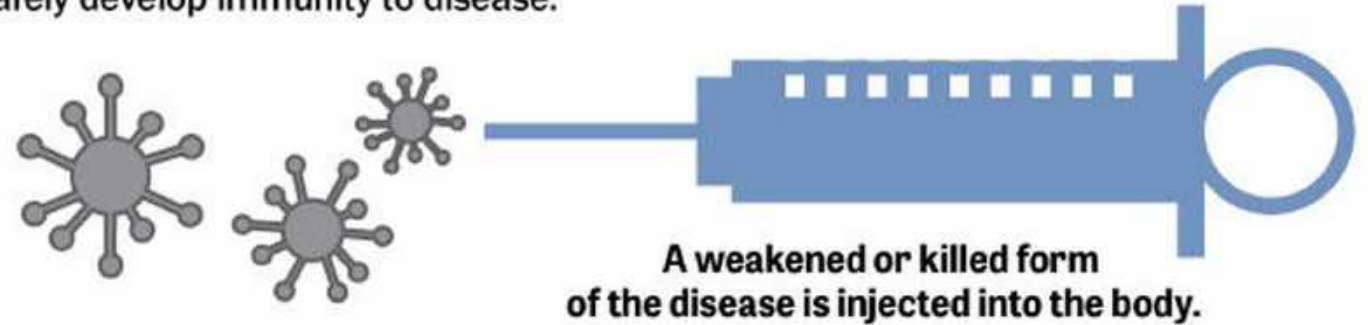
The New York Times, April 4, 2021

*“The best way to think about B.1.1.7 and other variants is to treat them as separate epidemics,” one expert said.*

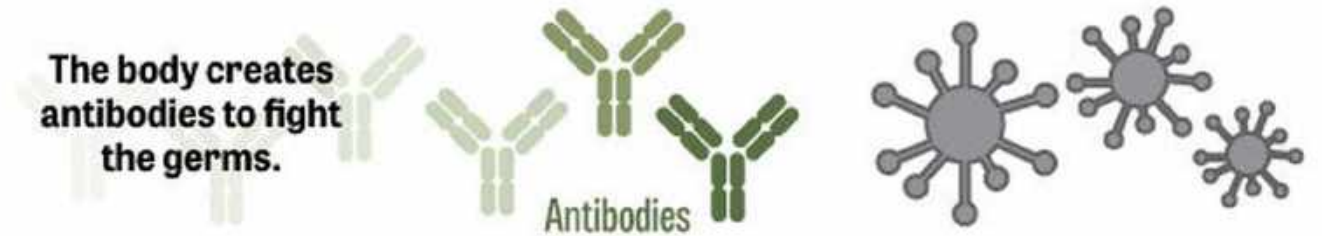
# How Do Vaccines Stop Viruses?

## HOW DO VACCINES WORK?

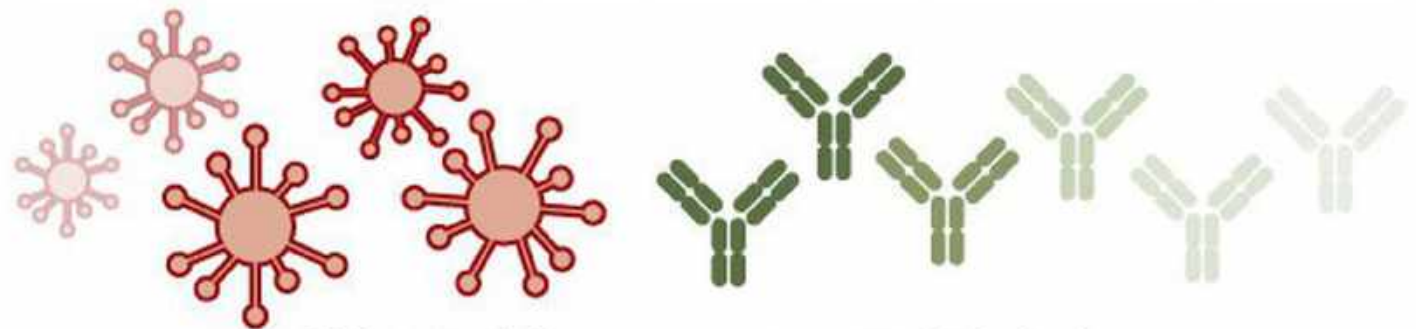
Vaccines reduce the risk of infection by working with the body's natural defenses to safely develop immunity to disease.



The body creates antibodies to fight the germs.



If the actual disease germs ever attack the body, the antibodies return to destroy them.





# Vaccine Development: Past & COVID-19

## PAST

- ▶ The measles virus was first isolated in 1954.
- ▶ Made by culturing a large quantity of weakened live virus in eggs
- ▶ Weakened virus prompts the immune system to produce antibodies and activate T cells
- ▶ Imprints a lasting “immune memory”
- ▶ Highly effective but no match for a host of new pathogens
- ▶ Very long timeline for development

## COVID-19

- ▶ Early identification of genetic sequence
- ▶ Early and frequent engagement between companies/academia, FDA and engagement with other governmental support
- ▶ Rapid pathway cleared by regulators to large scale human trials
- ▶ Rapid review and approval via EUA

# COVID-19 Variants

- ▶ More than **4,000 variants of COVID-19**, which have already killed more than 2.7 million people worldwide.
  - ▶ These variants may prove less susceptible to prevention with existing vaccines.
  - ▶ If so, updated vaccines will become critical to preventing future “waves” of infection.
  - ▶ A vaccine platform designed to rapidly adapt to changing pathogens would be invaluable to the United States.



# Innovation in Vaccine Development

MARK POZNANSKY, MD, PHD

# Need for Innovation

## Risks – possible future threats

- ▶ MERS – 202X
- ▶ Avian – 203X
- ▶ COVID variants - present

## Challenges with historical development paradigms

- ▶ Safety
- ▶ Efficacy
- ▶ Time to immunity

# SARS-CoV Variants: The Next Surge?



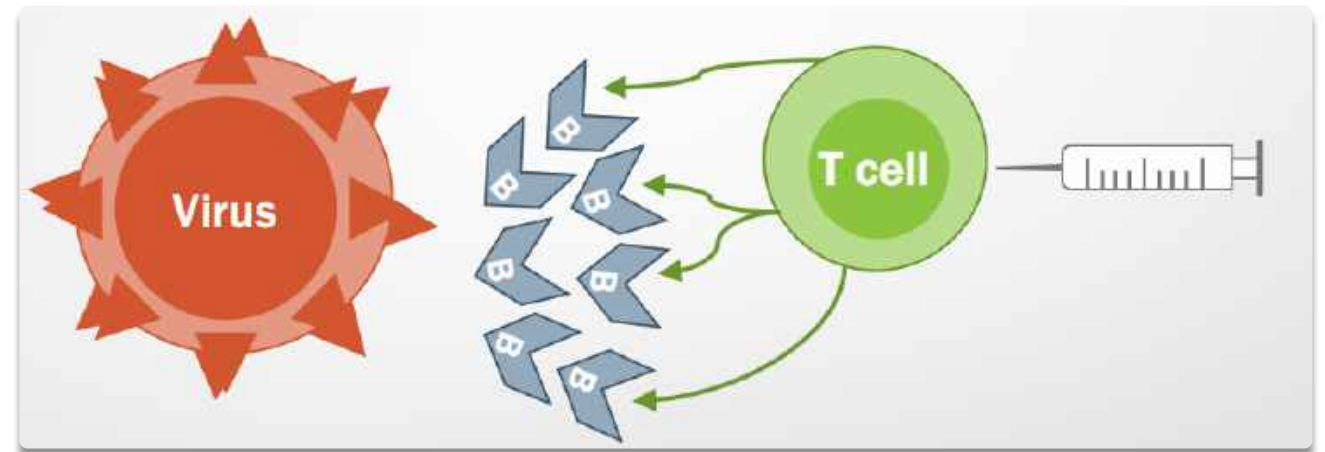
- ▶ 100s of COVID patients infected last spring were re-infected this winter.
- ▶ *Spike-only* vaccines speed variant selection (manuscript in Press; CDC studies underway).
- ▶ The *Whack-A-Mole* Problem: How to build a Fast, Agile Vaccine to wipe out COVID-19, COVID-21 and Beyond?


# Innovations in Vaccine Development

## RAPID VACCINE DEVELOPMENT PLATFORMS

- ▶ Can make and initially test a new vaccine in **less than 120 days**.
- ▶ Uses a **stock-piled vaccine adjuvant** which alerts the immune system to prepare to fight a pathogen.
- ▶ Vaccine is **90% ready** before any EID is identified.
  - ▶ Prepares the immune system to fight.
- ▶ Final 10% of the vaccine is **added when the EID is identified**.
  - ▶ Tells the immune system what it will be fighting and trains it to respond.
  - ▶ Can be tweaked right up to manufacturing.

## TARGETING THE T CELL





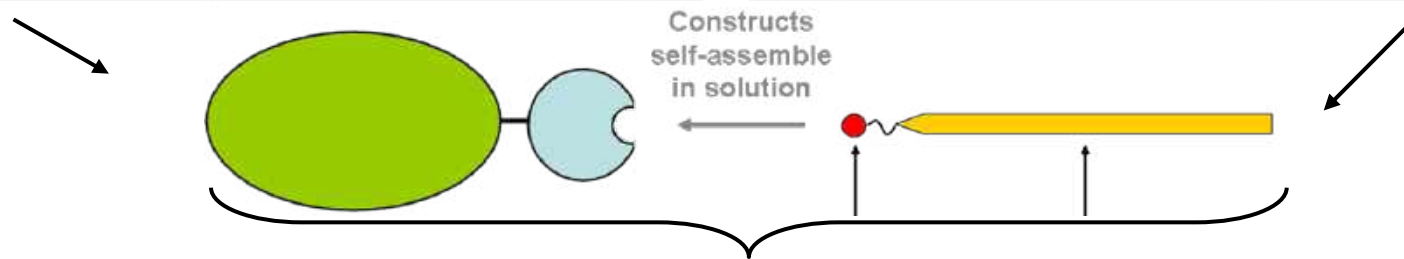
# Rapid Vaccine Development with Self Assembling Vaccines

PATRICK REEVES, PHD

# The Solution: Self Assembling Vaccine

- ▶ Can be produced in advance and stockpiled
- ▶ Capable of inducing both Th1 and Th2 responses
- ▶ Highly stable fusion protein

- ▶ Peptides based on *in silico* epitope design
- ▶ Can include both class I and class II epitopes
- ▶ Potential for rapid manufacture in “on demand” fashion for specific pathogen



- ▶ Same core design for every vaccine
- ▶ Highly stable lyophilized vaccine – stable up to 1 year at 68°F
- ▶ Does not include additional adjuvants or complex formulation



# Meeting COVID-19 Vaccine Challenges

Challenges	Proposed Self Assembling Vaccine	Advantages
Candidate Target ID	Antigen ID by shotgun mass spec or DNA seq	<ul style="list-style-type: none"><li>Keeps apace of viral sequencing efforts</li><li>Utilization of algorithms and accumulating data on immunogenic epitopes</li></ul>
Antigen selection	In silico antigen optimization	<ul style="list-style-type: none"><li>Enhance TCR fit</li><li>Eliminate cross-reactive epitopes</li><li>Optimize peptide design for cell processing</li><li>Adapt to emerging variants</li></ul>
Adjuvant Safety Concerns	Heat shock protein subunit delivery system	<ul style="list-style-type: none"><li>Low reactogenicity</li><li>Reduced toxicity</li><li>Targeting of antigen presenting cells</li><li>No depot/decoy effect</li></ul>
Scalability Cost control	Optimize peptide selection Nicotinia-based protein expression	<ul style="list-style-type: none"><li>Improve speed/cost of peptide production</li><li>Reduce cost of MTB-HSP70 production</li></ul>

# Development Timeline: Self Assembling Vaccine for COVID-19

Immunogenicity Study in Mouse Model



Efficacy Study in Hamster Model



Safety and Efficacy Study in NHPs



Safety and Efficacy Study in Humans

- ▶ Previously demonstrated we can generate an immunogenic vaccine within 120 days of receiving the sequence of the pathogen
- ▶ Proprietary epitope up and down selection
- ▶ Development path progressing in collaboration with an industry partner ongoing currently
- ▶ Regulatory path determination in process
- ▶ Need for adaptable room temperature stable vaccine platform that can be iterated for variants in near real-time and re-used as needed without the concern for anti-vector or anti-drug antibodies impacting its re-use.



# How Can Congress Support Vaccine Development Innovations?

PAT GALLAGHER

# How Can Congress Support Vaccine Development Innovations?

## Labor, Health and Human Services Appropriations Request

- Increase National Institute of Allergy and Infectious Diseases (NIAID)'s Biodefense and Emerging Infectious Disease line **by \$50M to support research and development of rapid vaccine development platform.**

## Department of Defense Appropriations Request

- Increase Army, RDT&E, Medical Advanced Technology line **by \$10M to support rapid vaccine development platforms and collaborations** for R&D and manufacturing of vaccines.



# QUESTIONS

Please type your questions in the Q&A box