



CAETS 2021
ARGENTINA
Engineering a Better World
THE FUTURE OF ENERGY



Buenos Aires, September 17-24, 2021

EVALUATION OF COVID-19 IMPACT

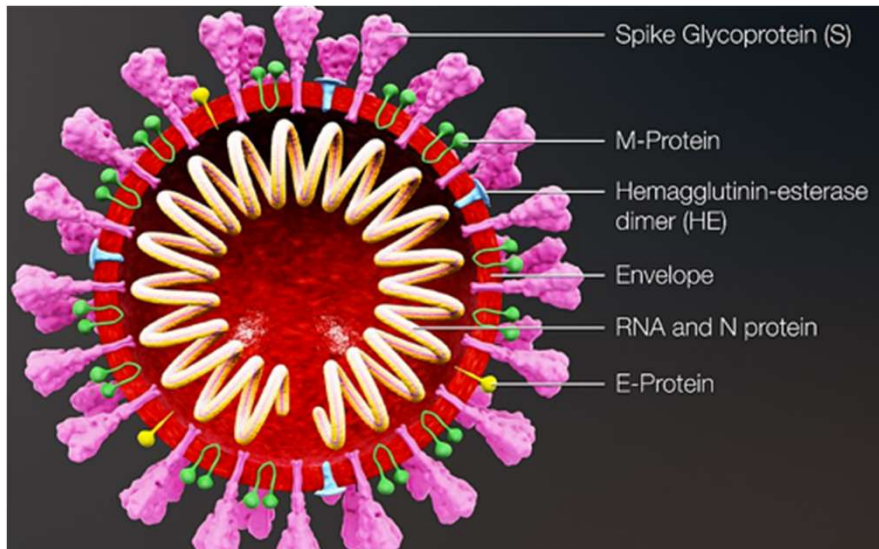
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Harvard Medical School

COVID-19 is still a major threat

- SARS-COV-2 spreads easily between individuals
- The severity of the resulting illness can be high



Scientific Animations™

> 200,000,000 Cases

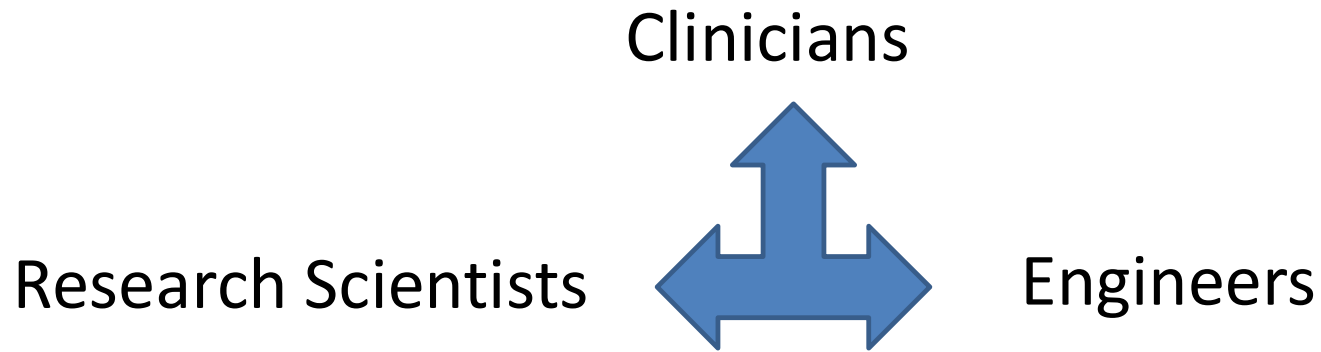
> 4,500,000 Deaths

4,000,000,000 Vaccine Doses

World Health Organization



An Important Lesson



Viral Sequence



Zhu, N. et al. A novel coronavirus from patients with pneumonia in China, 2019. *N. Engl. J. Med.* **382**, 727–733 (2020).



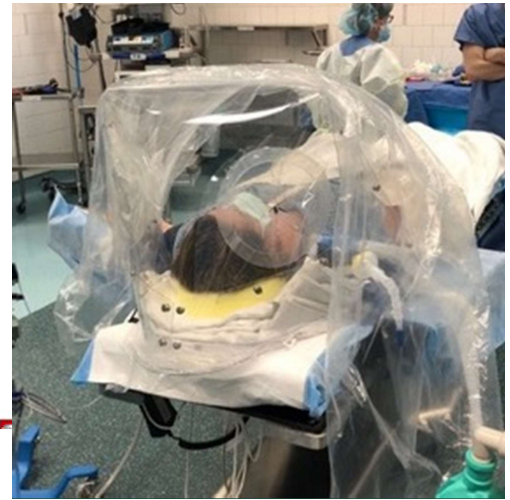
Pandemic Needs

- Devices
- Diagnostics
- Therapeutics
- Data Analytics



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Devices



Personal Protective Equipment



Face
masks

Face Shields

N 95



Additional Devices



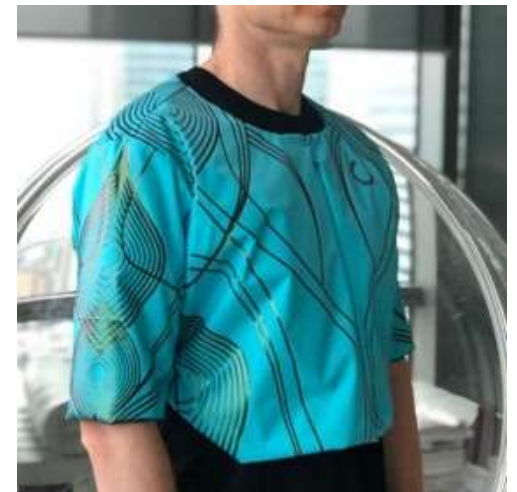
Patient Isolation
Hoods



Swabs



Ventilators



Virtual Hug Shirt



Devices—Lessons Learned

- Devices were rapidly prototyped and scaled
- Additive manufacturing transformed ability to meet local supply needs for smaller devices
- Supply chain is global but when countries need for their own use, domestic needs take precedent.
- Critical supplies should be stocked in advance of need



Diagnostics

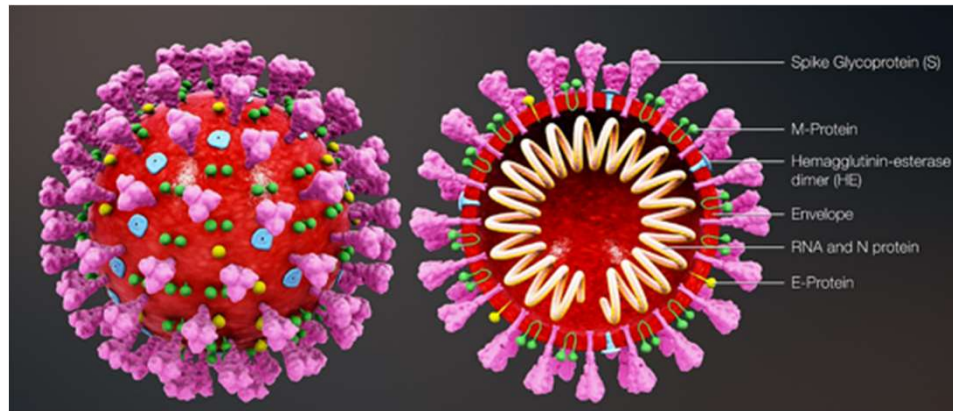


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What to Test



RNA

Antibodies

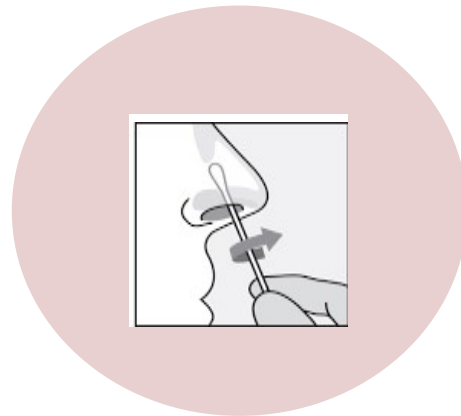
Antigens



Diagnostics—How do we sample?



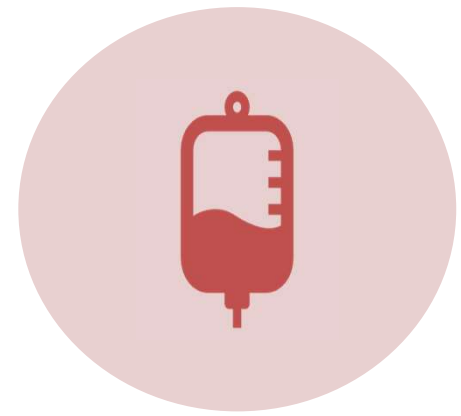
NASOPHARYNGEAL



ANTERIOR NASAL



SALIVA



BLOOD



Where to Test



Central Lab



Point of
Care/Service



At home



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Other Testing



Pooled testing



Wastewater monitoring



What went wrong?

- Initial tests were flawed and led to many false results
- Nearly 2000 companies got into the COVID testing business
- Validation was done by companies
- Large diagnostics companies in stealth mode



Diagnostics—Lessons learned

- Coordination necessary at governmental level
- Supplies are finite so need to be deployed where needed rather than who can pay.
- Distributed testing
- Independent validation
- Innovation is important but scale is more important

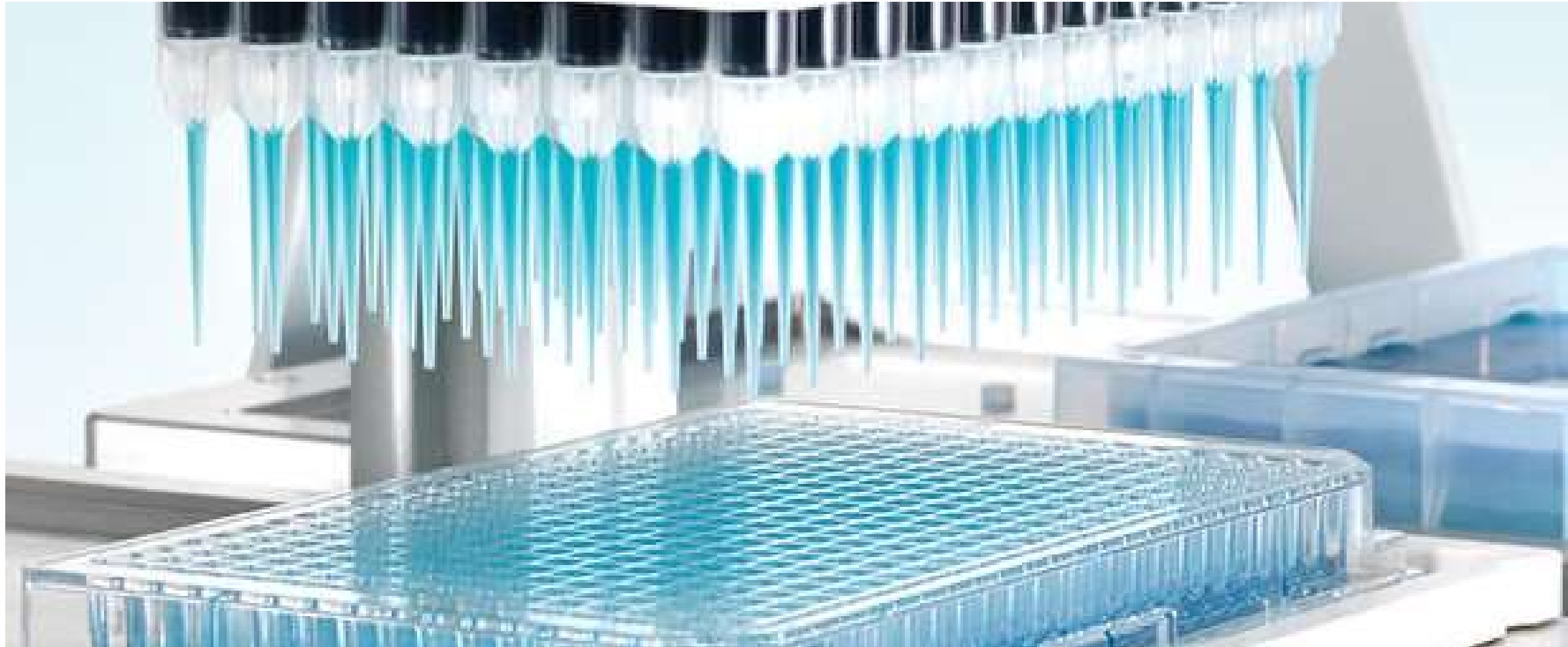


Therapeutics

- Repurposed Drugs
- Convalescent plasma
- Monoclonal antibodies
- Vaccines



Repurposed Drugs

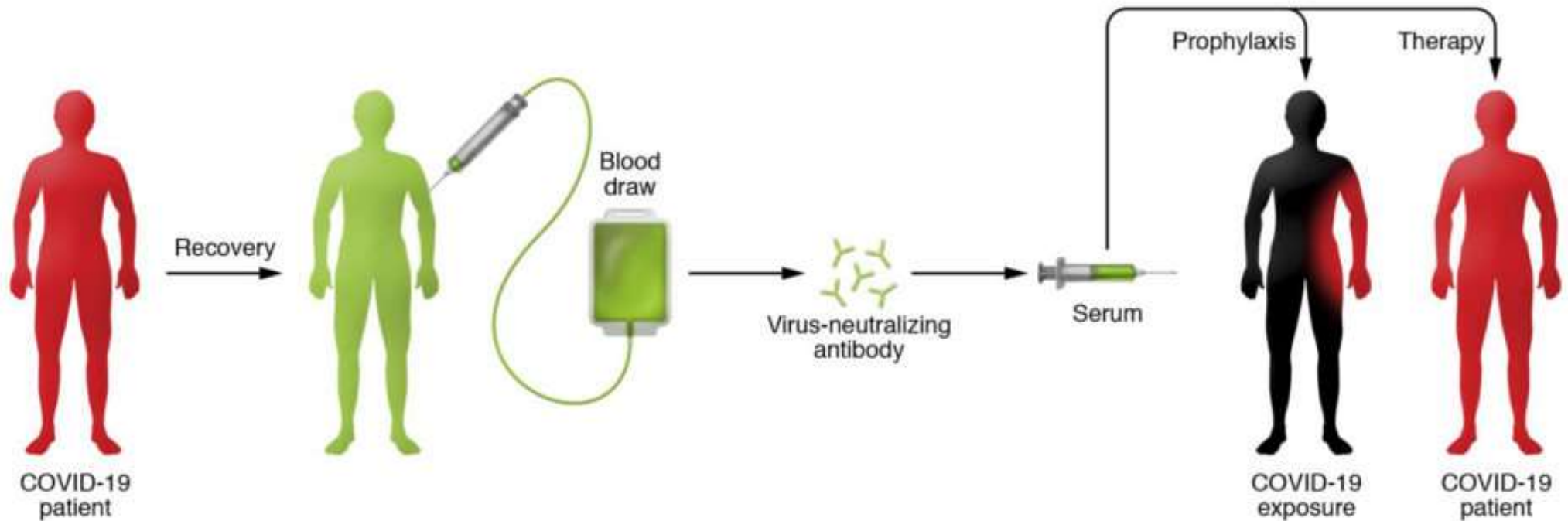


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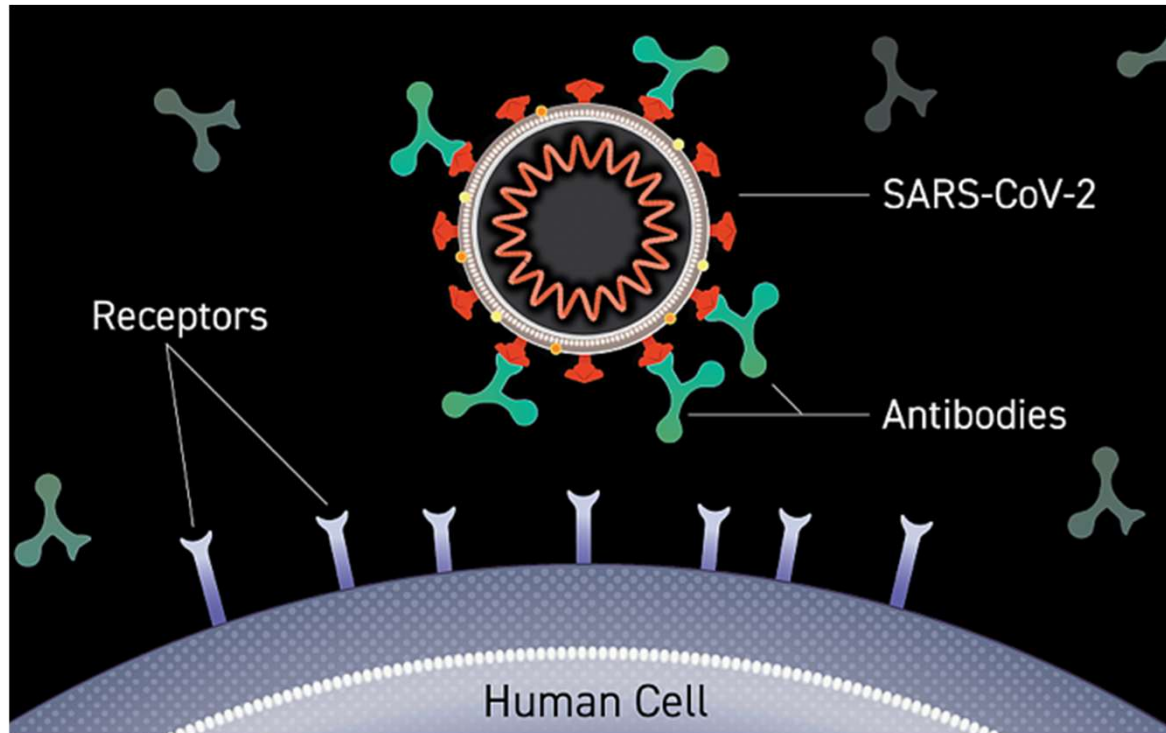
Convalescent Plasma



J Clin Invest. 2020. <https://doi.org/10.1172/JCI138003>



Monoclonal antibodies



NIH.gov

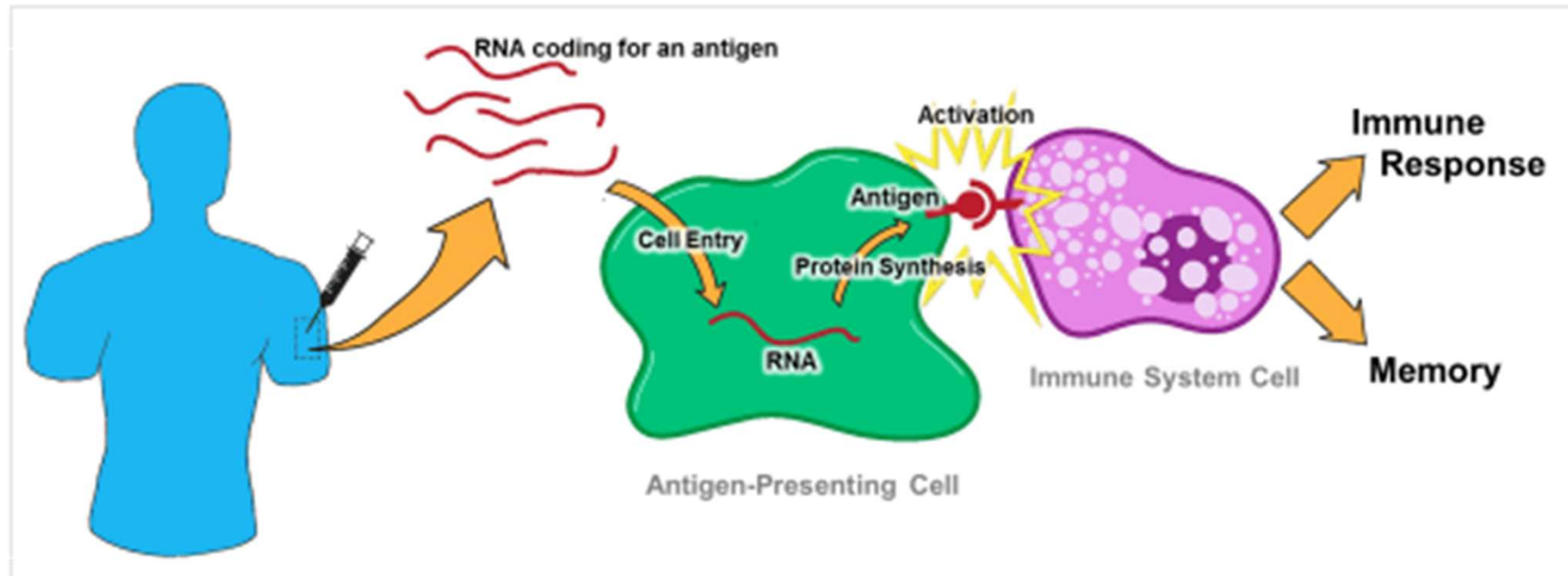


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Vaccines

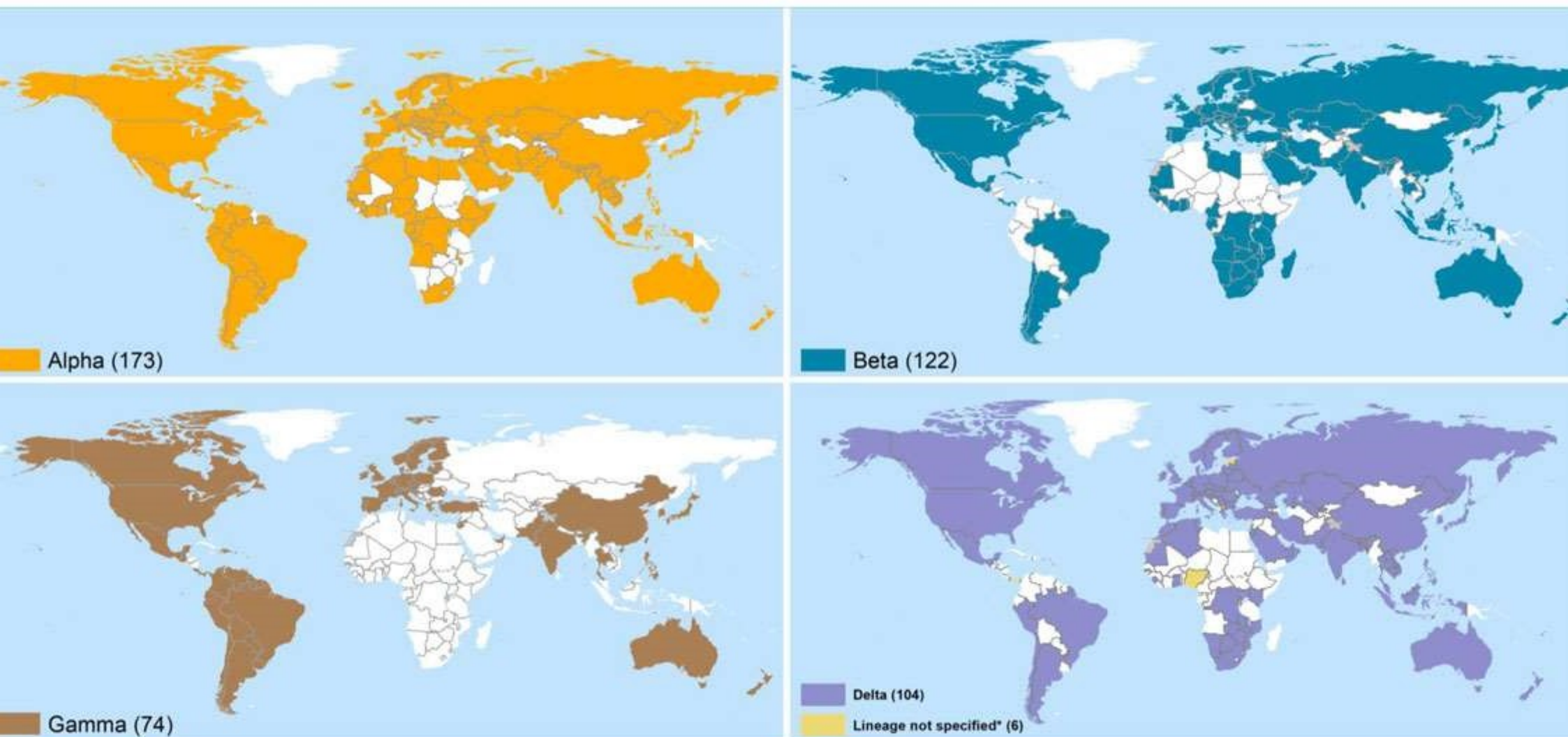


Vaccines

- RNA and DNA vaccines
- Engineered viruses
- Inactivated viruses

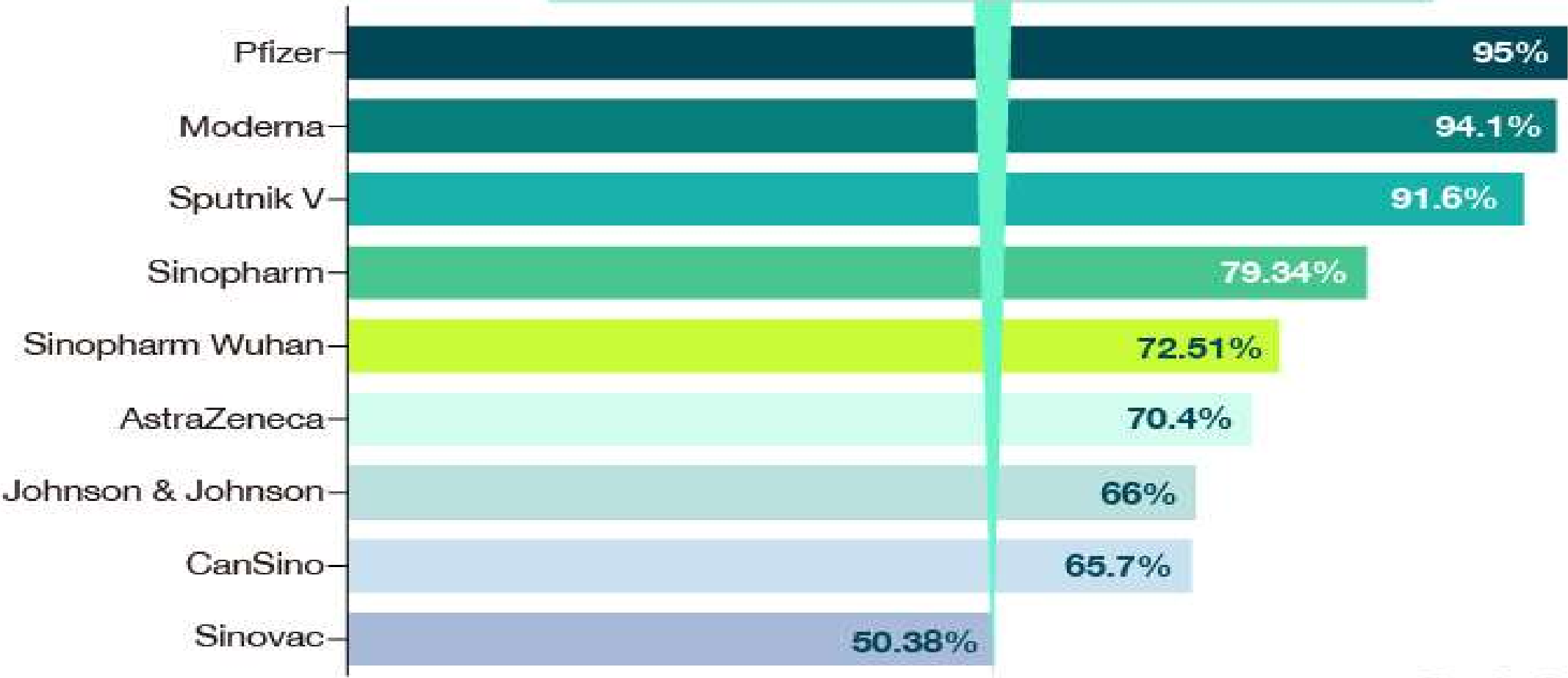


Figure 4. Countries, territories and areas reporting variants Alpha, Beta, Gamma and Delta, as of 6 July 2021**



Efficacy of Nine Covid-19 Vaccines

Minimum efficacy recommended by the WHO: **50%**



Sources: Caixin reports, Lancet, World Health Organization

Therapeutics—Lessons Learned

- Rapid drug discovery is possible through repurposing
- Vaccines can be rapidly developed and tested but manufacturing capacity and distribution remain issues.
- Critical supplies must be ensured
- Controlled blinded studies



Data and Analytics



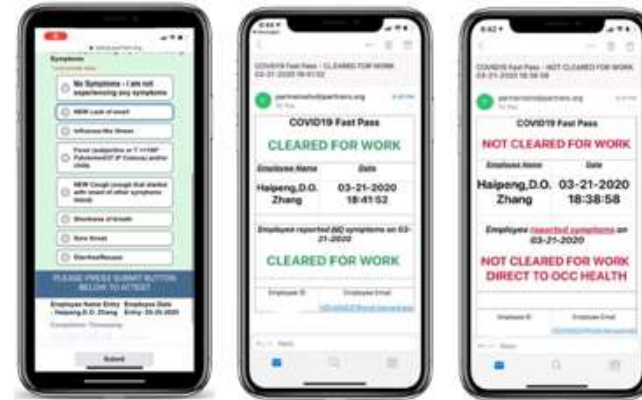
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Mobile Health

Electronic Patient-Reported Outcome



Wearable Sensors



Digital Contact Tracing



Contact Tracing



Contact event detected



Phones broadcast randomly generated CEN



Phone keeps log of transmitted and received CENs



Permission # provided upon diagnosis



Permission # and CENs sent to public database



Phone matches local CENs with public database



Lessons from COVID-19 for Climate Change

- Deep collaboration between clinicians, engineers, and scientists; academics industry, NGOs, governments
- Global problem that requires global cooperation
- Local solutions required
- Distributed and reliable supply chain
- Engineers and all fields of engineering essential
- It's not over.





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THANK YOU

Author