IMMUNISATION COALITION

COVID-19 and Disease X

8:20 pm

Prof Kanta Subbarao

WHO Collaborating Centre for Reference and Research on Influenza & Department of Microbiology and Immunology, University of Melbourne, Peter Doherty Institute for Infection and Immunity

COVID-19 and Disease X

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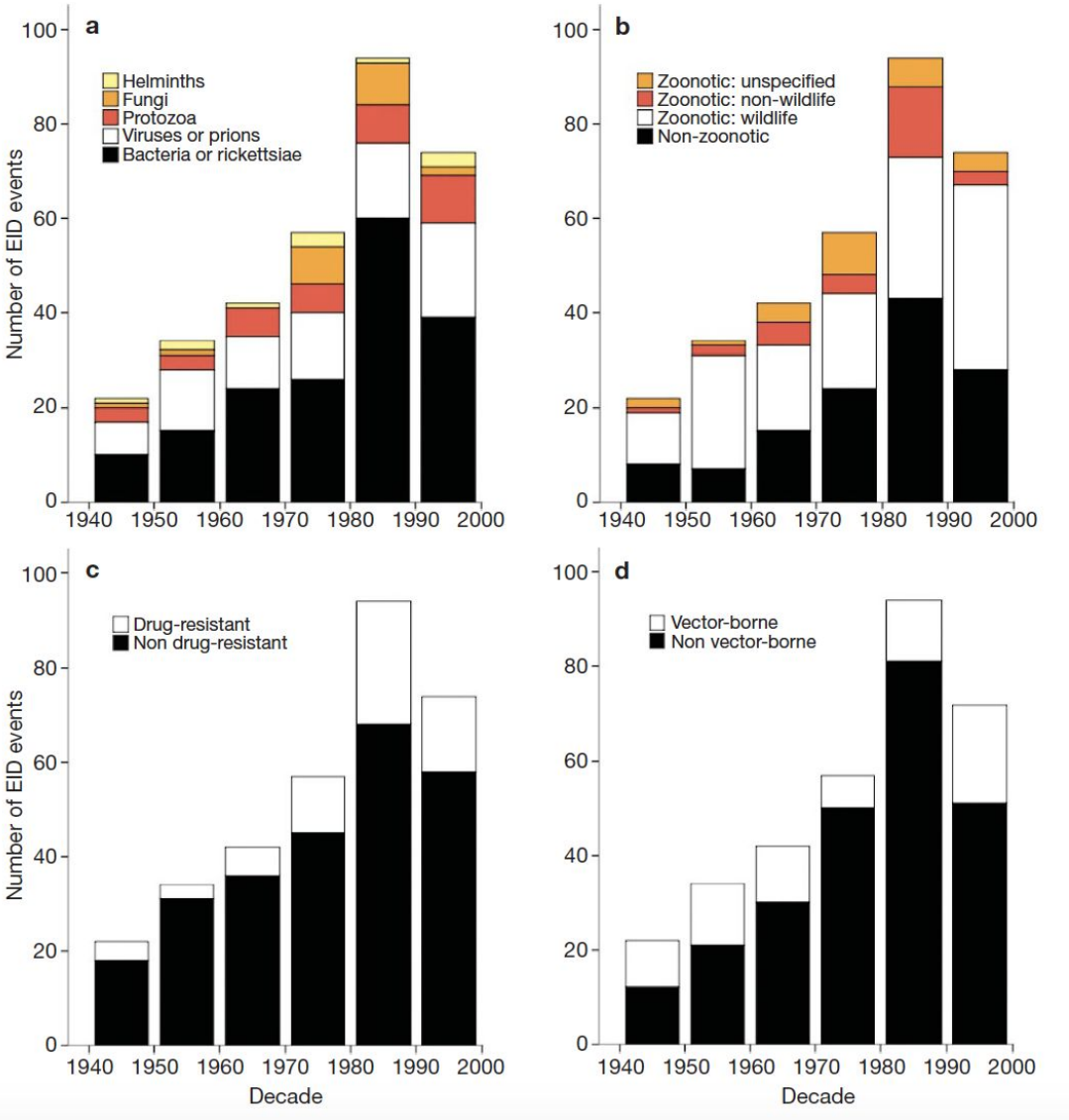
Emerging Infectious Disease Events by Decade

Pathogen

Transmission type

Drug resistance

Transmission mode



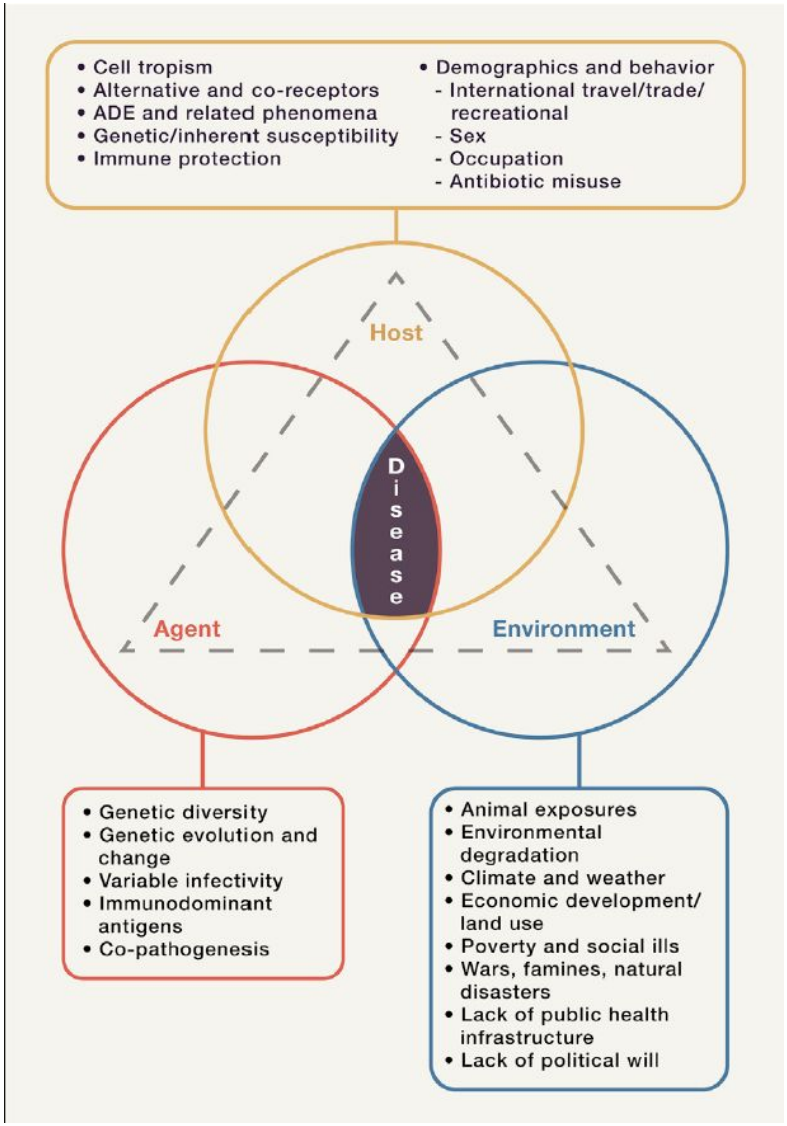
Jones et al *Nature* 2008 Vol 451| doi:10.1038/nature06536

Major factors underlying disease emergence and re-emergence

The Microbial Agent	The Human Host	The Human Environment
Genetic adaptation and change	Human susceptibility to infection	Climate and weather
Polymicrobial diseases	Human demographics and behavior	Changing ecosystems
	International trade and travel	Economic development and land use
	Intent to harm (bioterrorism)	Technology and industry
	Occupational exposures	Poverty and social inequality
	Inappropriate use of antibiotics	Lack of public health services
		Animal populations
		War and famine
		Lack of political will

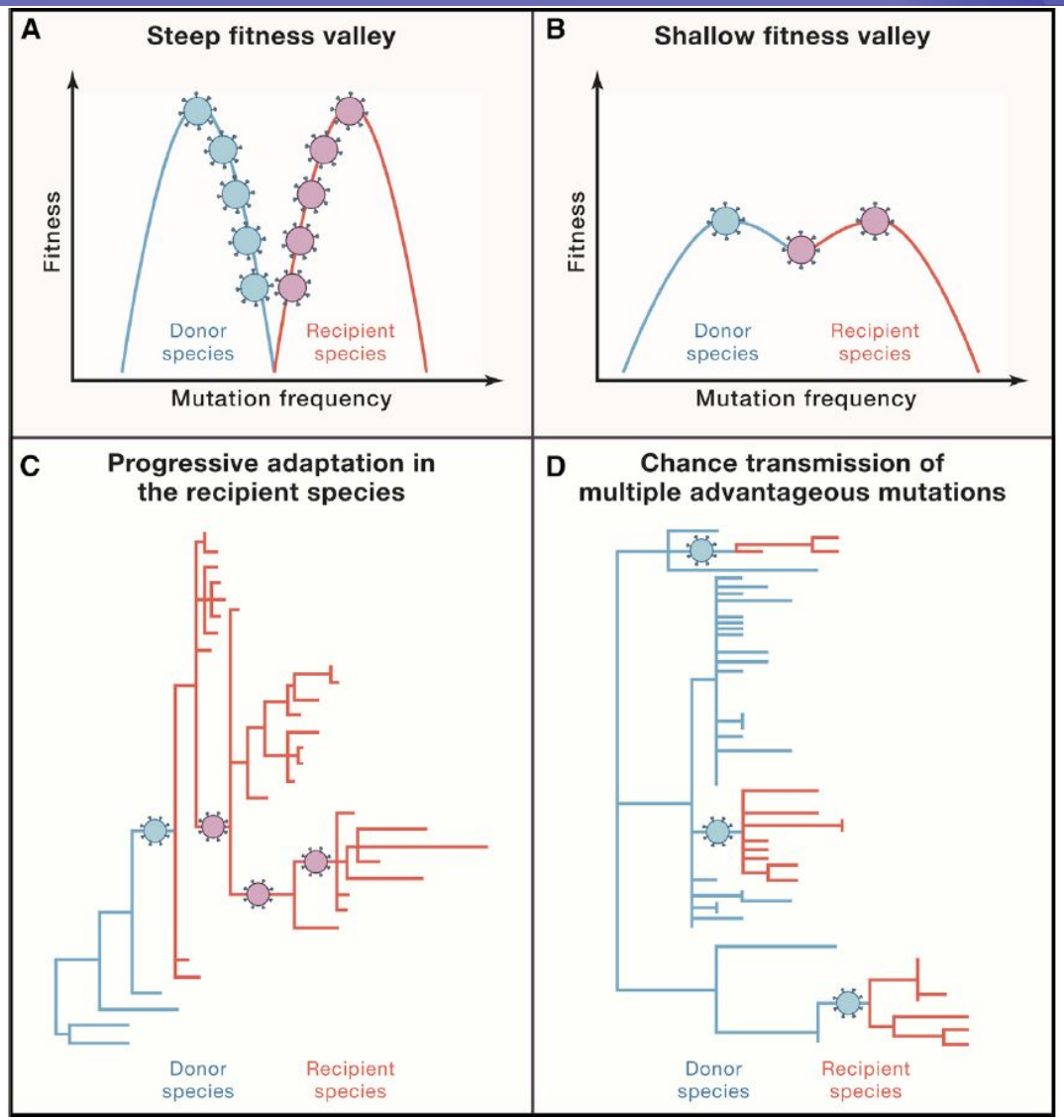
Morens and Fauci *PLoS Path* 2013 | Volume 9 | e1003467

Determinants of disease emergence and re-emergence



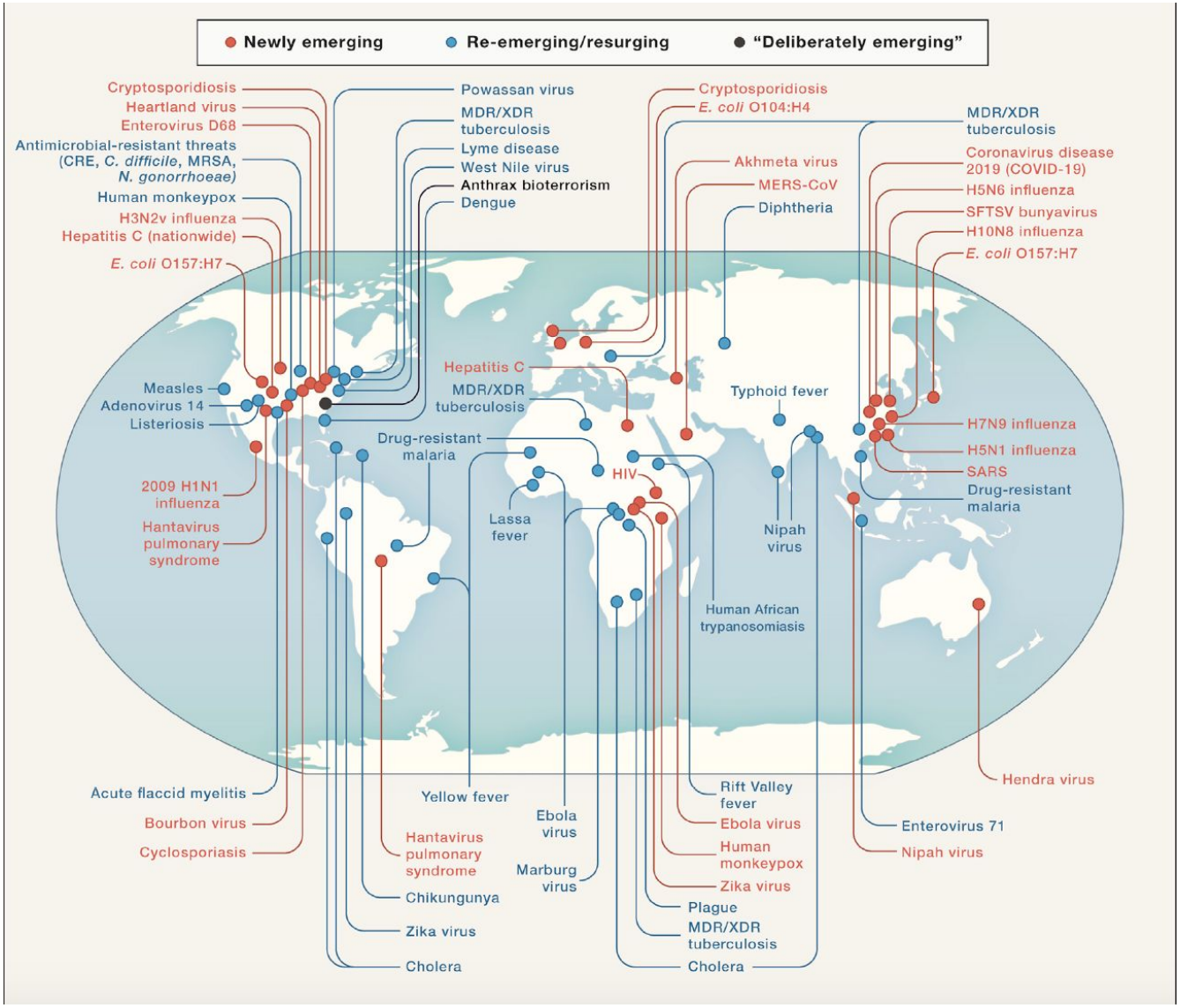
Morens and Fauci *Cell* 2020 | 182 | 1077-1092

Molecular mechanisms of host-switching



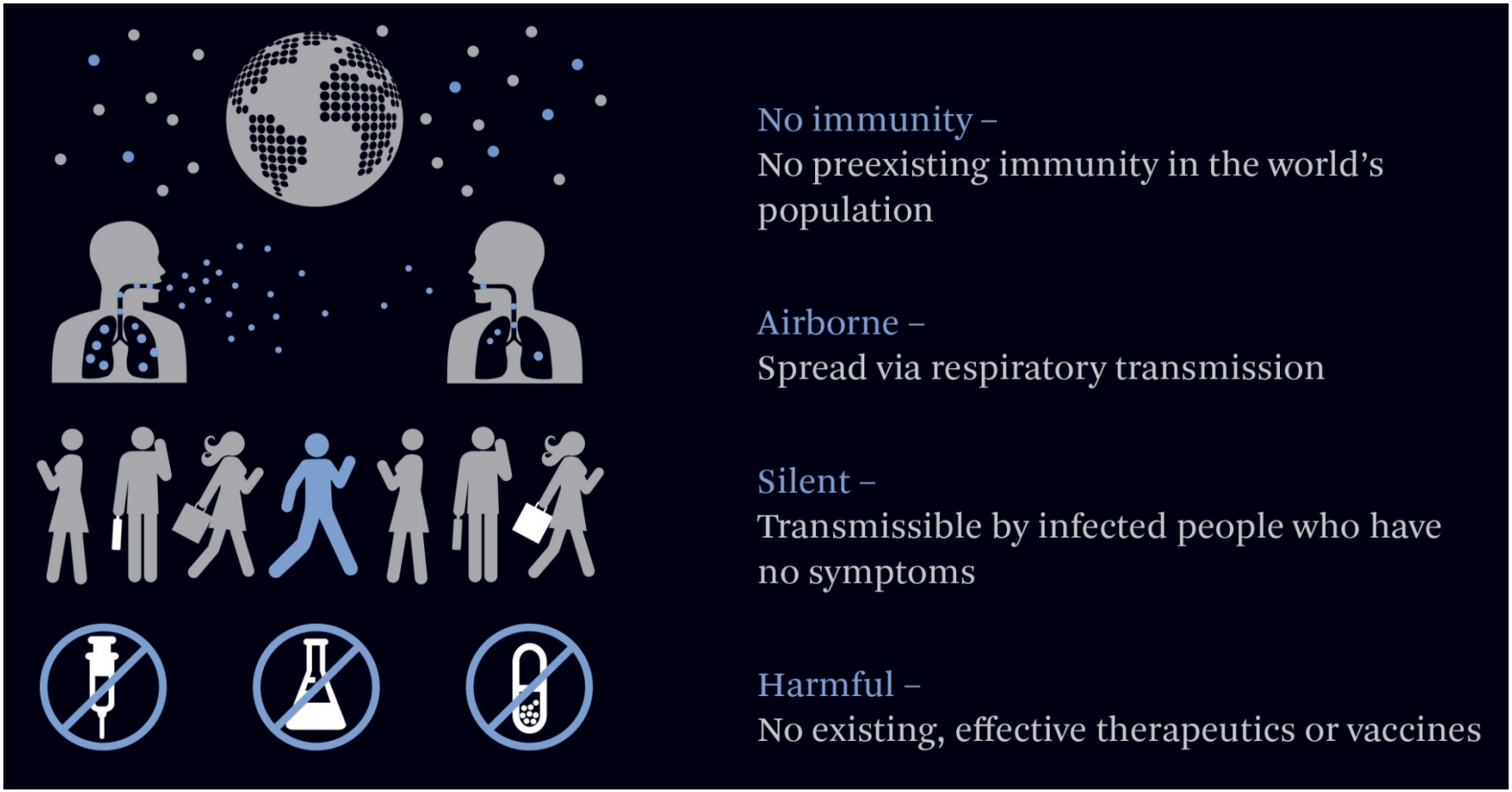
Morens and Fauci *Cell* 2020 | 182 | 1077-1092

Emerging pandemic diseases 1981-2020



Morens and Fauci *Cell* 2020 | 182 | 1077-1092

Traits of potential pandemic pathogens



https://centerforhealthsecurity.org/our-work/research-projects/disease-x-medical-countermeasure-program

Lessons learned in the COVID-19 pandemic

- Novel coronavirus
- Receptor: ACE2 shared with SARS-CoV and NL63
- Efficiently transmitted from person to person
- Asymptomatic and mildly symptomatic people can spread the virus but superspreading events occur
- Airborne and fomite transmission

Successes and challenges with SARS-CoV-2

- Molecular diagnostics, next gen sequencing and data sharing
- Rapid vaccine development
  - New mRNA platform
  - Rapid clinical trials
  - New regulatory approach to approval of vaccines
  - Adverse events: Myocarditis and pericarditis, TTP
  - Emergence of variants
  - Inequities in availability
  - Poor uptake
- Monoclonal antibodies to the Spike protein
  - Rapid development of human mAbs
  - Immune escape variants

WHO COVID-19 advisory group landscape

Aim: Monitor & assess SARS-CoV-2 variants and evaluate their impact on countermeasures, including vaccines, therapeutics, diagnostics or effectiveness of public health and social measures.

TAG-VE

- Determines which variants warrant further investigations
- Assesses whether variants alter
  - transmission or disease characteristics or
  - impact vaccines, therapeutics, diagnostics or
  - effectiveness of public health and social measures

R&D Blueprint for epidemics

- COVID-19 Vaccines Research Expert Group

TAG-CO-VAC

- Assesses the impact of Variants of Concern on current COVID-19 vaccines
- Determines whether changes to vaccine composition are needed

SAGE

- Advises on vaccine use and implementation

Technical Advisory Group on COVID-19 Vaccine Composition

Chair

Professor Kanta Subbarao

Director of the WHO Collaborating Centre for Reference and Research on Influenza and Professor, Department of Microbiology and Immunology

Learn more ›

Vice-Chair

Dr David Wentworth

Chief of the Virology, Surveillance, and Diagnosis Branch (VSDB) of the Influenza Division at the U.S. Centers for Disease Control and Prevention (CDC)

Learn more ›

Members

Dr Supamit Chunsuttiwat ›
Advisor, Department of Disease Control, Ministry of Public Health THAILAND

Professor Cheryl Cohen ›
Professor in epidemiology at the University of the Witwatersrand and Head of the Centre for Respiratory Disease and Meningitis at the National Institute for Communicable Diseases

Professor John Peter Figueroa ›
Professor of Public Health, Epidemiology and HIV/AIDS at the University of the West Indies

Professor David Goldblatt ›
Professor of Vaccinology and Immunology and Head of the Immunobiology Section at the Great Ormond Street Institute of Child Health

Ziad Memish ›
Infectious Disease Consultant and Director, Research Centre, King Saud Medical City, Ministry of Health Kingdom of Saudi Arabia

Professor Priya Abraham ›
Director of Indian Council of Medical Research

Professor Paul Fine ›
Professor of Communicable Disease Epidemiology

Dr Hideki Hasegawa ›
Director of the WHO Collaborating Centre for Reference and Research on Influenza, Japan

Professor Elizabeth Miller ›
Professor in Infectious Disease Epidemiology at the London School of Hygiene and a visiting professor at the Sackler School of Public Health at Tel Aviv University

Professor Samba O. Sow ›
Director-General of the Center for Vaccine Development

Dr Oyewale Tomori ›
Member of the Global Virome Project Leadership Board

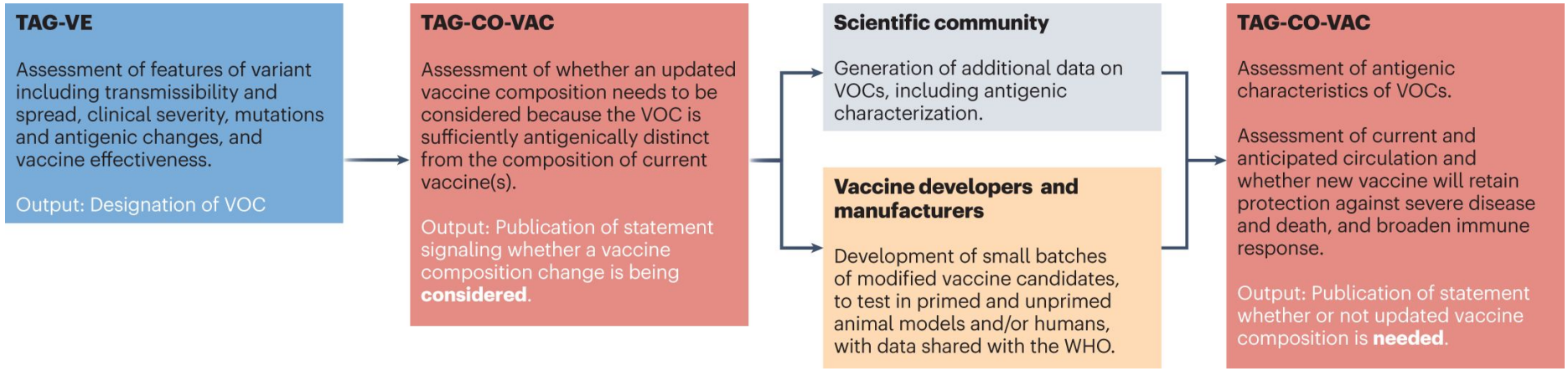
Professor Raina MacIntyre ›
Head of Biosecurity Research Program in Kirby Institute

Dr Sergio Nishioka ›
Technical Adviser for Capacity Building and Clinical Evaluation of COVID-19 vaccines

World Health Organization

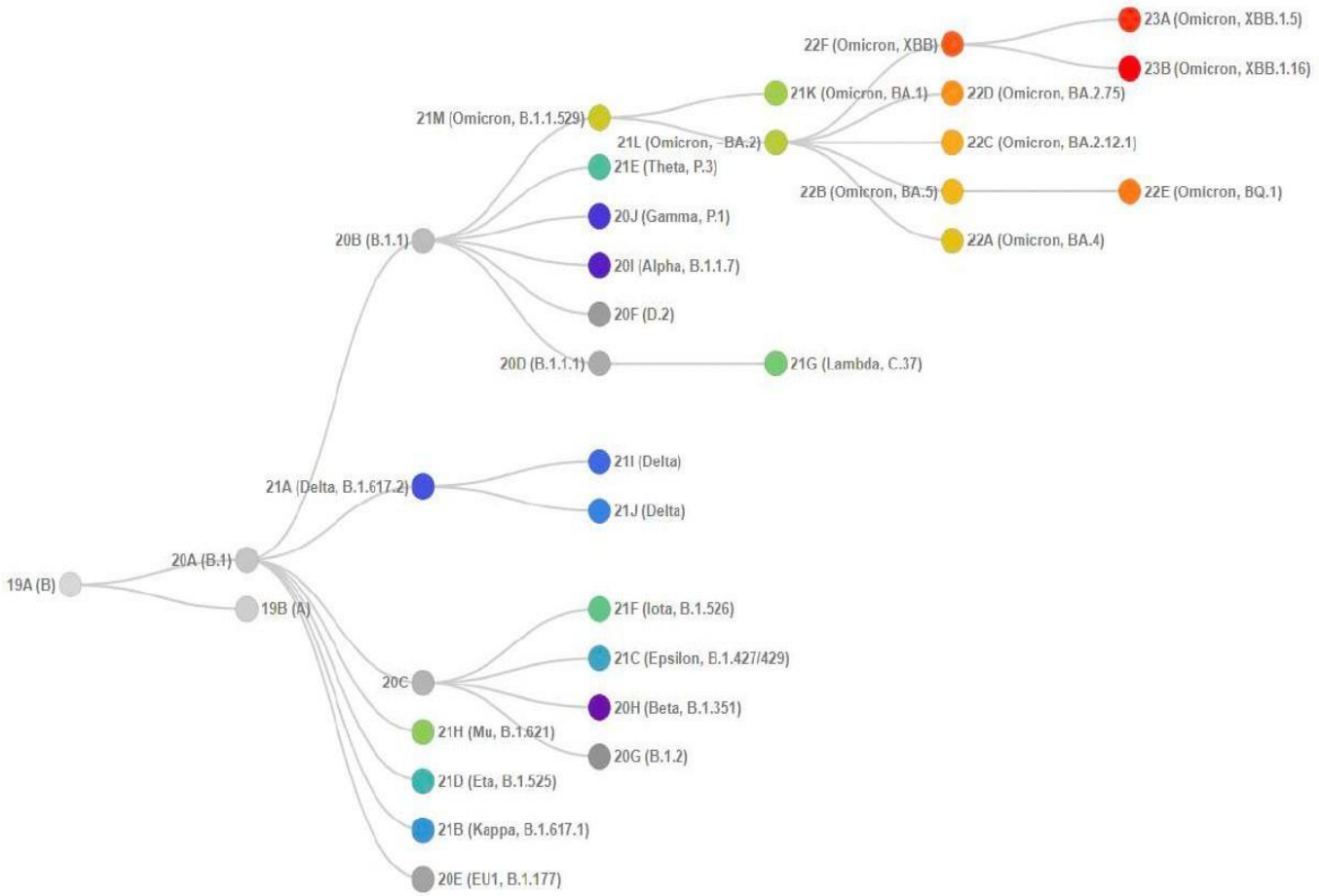
https://www.who.int/groups/technical-advisory-group-on-covid-19-vaccine-composition-(tag-co-vac)

The current decision-making process of TAG-CO-VAC



https://www.nature.com/articles/s41591-023-02220-y

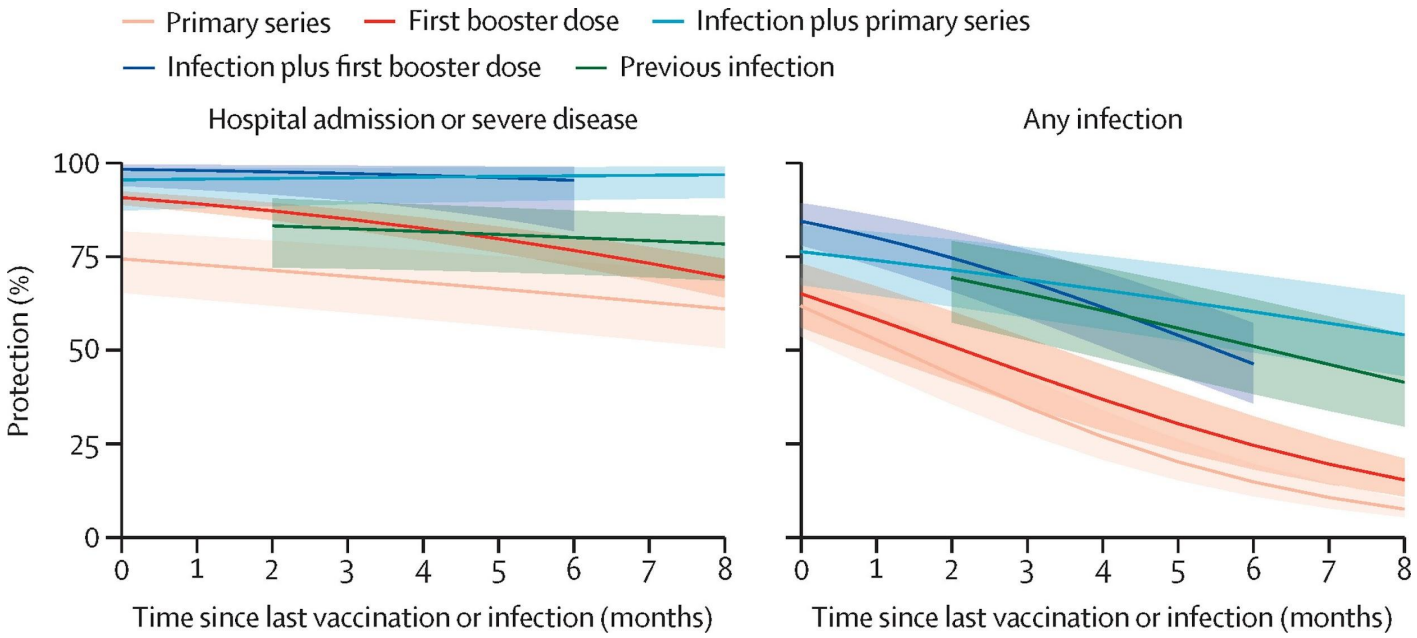
SARS-CoV-2 evolution



Simplified illustration of phylogenetic relationships of SARS-CoV-2 clades, as defined by Nextstrain

Nextstrain: https://clades.nextstrain.org

Protective effectiveness of hybrid immunity



Protection against Omicron variant conferred by the primary series vaccine, first booster vaccine, previous infection, and hybrid immunity compared to immune-naive individuals over time

The shaded areas denote 95% CIs. Vaccine effectiveness data were procured from a separate systematic review

Bobrovitz N, et al. Lancet Infect Dis. 2023;23(5):556-567.

World Health Organization

Overall seroprevalence is high in all regions, as a result of vaccination and/or infection

WHO region	Aug 2021	Oct 2021	Dec 2021	Feb 2022	Apr 2022	Jun 2022
Americas (HIC)	84.4% [48.6%-96.9%]	93.5% [87.1%-96.8%]	95.4% [93.2%-97.0%]	97.7% [97.5%-97.9%]	99.8% [99.7%-99.8%]	100.0% [64.1%-100.0%]
Western Pacific	No data	34.0% [28.9%-39.5%]	30.0% [25.1%-35.4%]	97.2% [95.0%-98.5%]	No data	99.0% [98.7%-99.2%]
Europe (HIC)	81.1% [68.5%-89.4%]	88.7% [82.1%-93.1%]	94.1% [84.8%-97.9%]	94.0% [89.1%-96.7%]	95.2% [92.7%-96.8%]	96.1% [92.3%-98.1%]
South-East Asia	69.0% [65.6%-72.3%]	84.7% [81.4%-87.5%]	90.6% [90.3%-90.9%]	No data	No data	No data
Americas (LMIC)	85.0% [84.1%-85.8%]	No data	No data	No data	86.5% [84.0—88.7%]	No data
Africa	60.9% [50.7%-70.3%]	73.1% [72.0%-74.1%]	80.1% [71.8%-86.5%]	82.5% [62.6%-93.0%]	84.7% [72.6%-92.1%]	No data
Europe (LMIC)	No data	79.6% [77.9%-81.2%]	No data	No data	No data	No data
Eastern Med.	74.1% [73.2%-75.0%]	75.8% [72.9%-78.5%]	No data	No data	No data	No data
Global	45.8% [43.2%-48.5%]	70.0% [67.8%-72.2%]	72.4% [70.1%-74.7%]	89.5% [87.8%-91.0%]	89.8% [87.8%-91.4%]	

Seroprevalence varied by region, with many regions nearing 100% in 2022

Key: ≥ 80%, ≥ 60%, ≥ 40%, ≥ 20%, ≥ 0%, White shading indicates n=1 study to analyze in month, region
No data: absence of general population study, or of low or moderate risk of bias studies, to analyze in month, region.

Seroprevalence increased from Aug 2021 to Jun 2022 in all regions

World Health Organization

TAG-CO-VAC Plans

- The TAG-CO-VAC will meet twice a year to review data and discuss whether an update of the vaccine antigen is warranted.
- We are coordinating with regulators and manufacturers/developers and will have an Information Meeting after the vaccine composition discussions.

World Health Organization

What is Disease X?

- **What is Disease X?**
  - Disease X is the name given to an unknown pathogen that could emerge in future and cause a serious epidemic or pandemic.
- **Does Disease X exist?**
  - Hypothetical, but the concept describes a real and growing threat to human health
- **When will Disease X happen?**
  - The chance of a pandemic, with an impact like COVID-19, is ~ 1 in 50 in any year.
  - The lifetime probability of experiencing a pandemic like COVID-19 is ~ 38 percent.
  - Environmental change contributes to increased risk

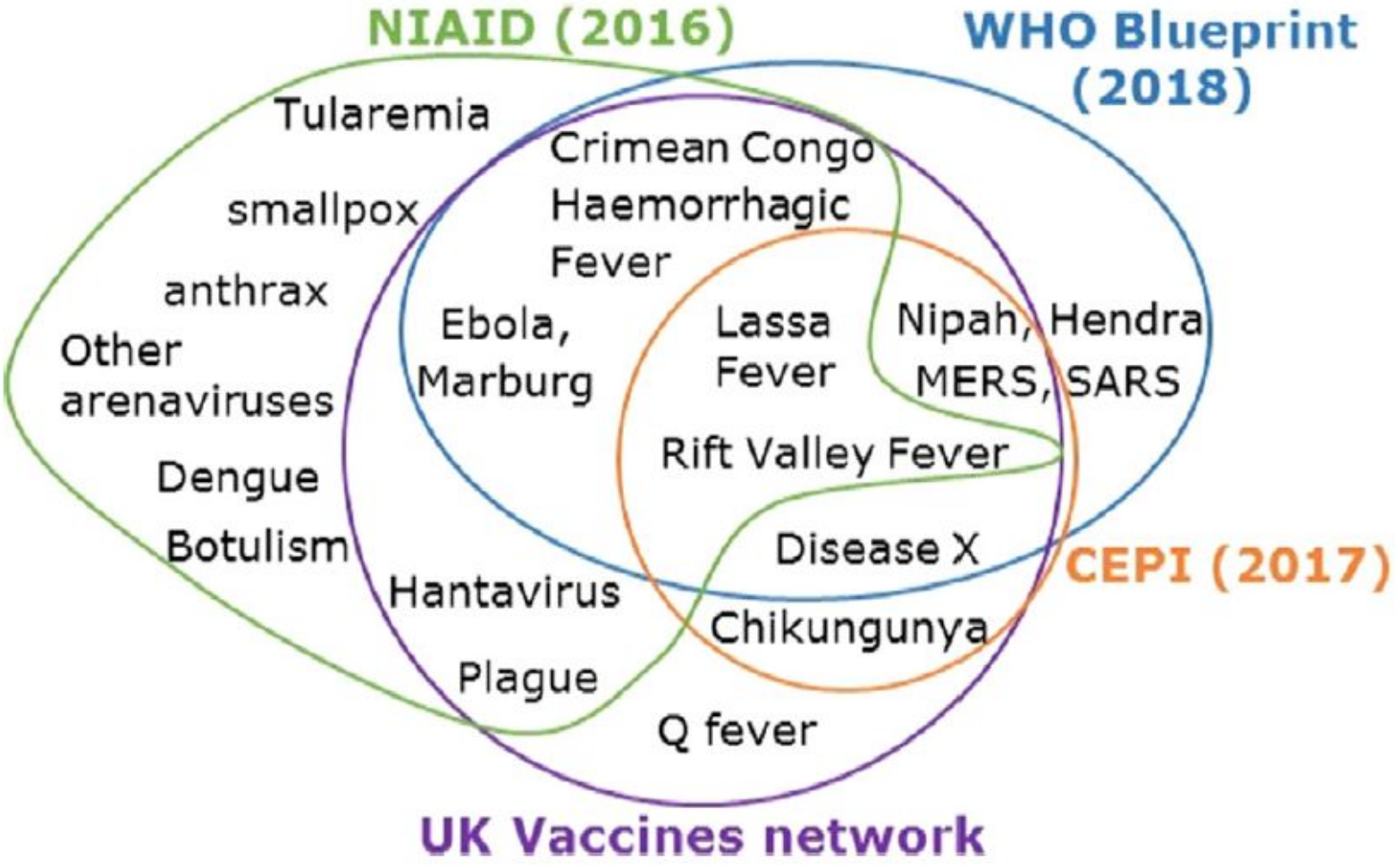
https://cepi.net/news_cepi/

What is Disease X?

- **Will Disease X cause the next pandemic?**
  - The next pandemic threat could emerge as a novel Disease X or re-emergence of a known pathogen
- **Where will the next Disease X come from?**
  - the next Disease X is highly likely to be caused by a new virus that will emerge from one of ~ 25 virus families that have already caused disease in people.
- **How can we prepare today for Disease X?**
  - Learn as much as we can about the 25 viral families that are most likely to harbour a novel Disease X
- **CEPI's 100 Days Mission:**
  - make new vaccines against known or novel infectious diseases within three months of their pandemic threat being recognised

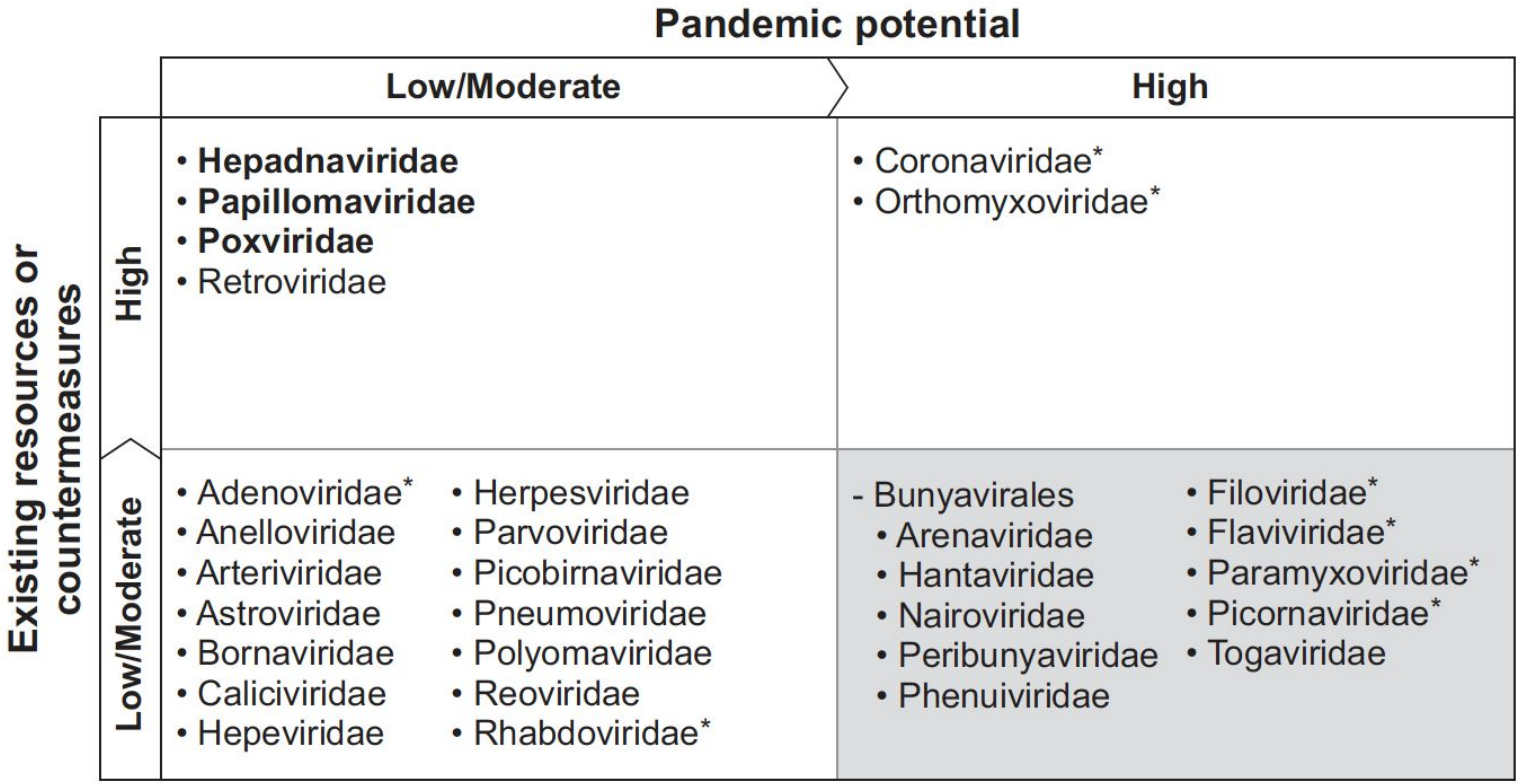
https://cepi.net/news_cepi/

Priority Pathogens Lists: UK



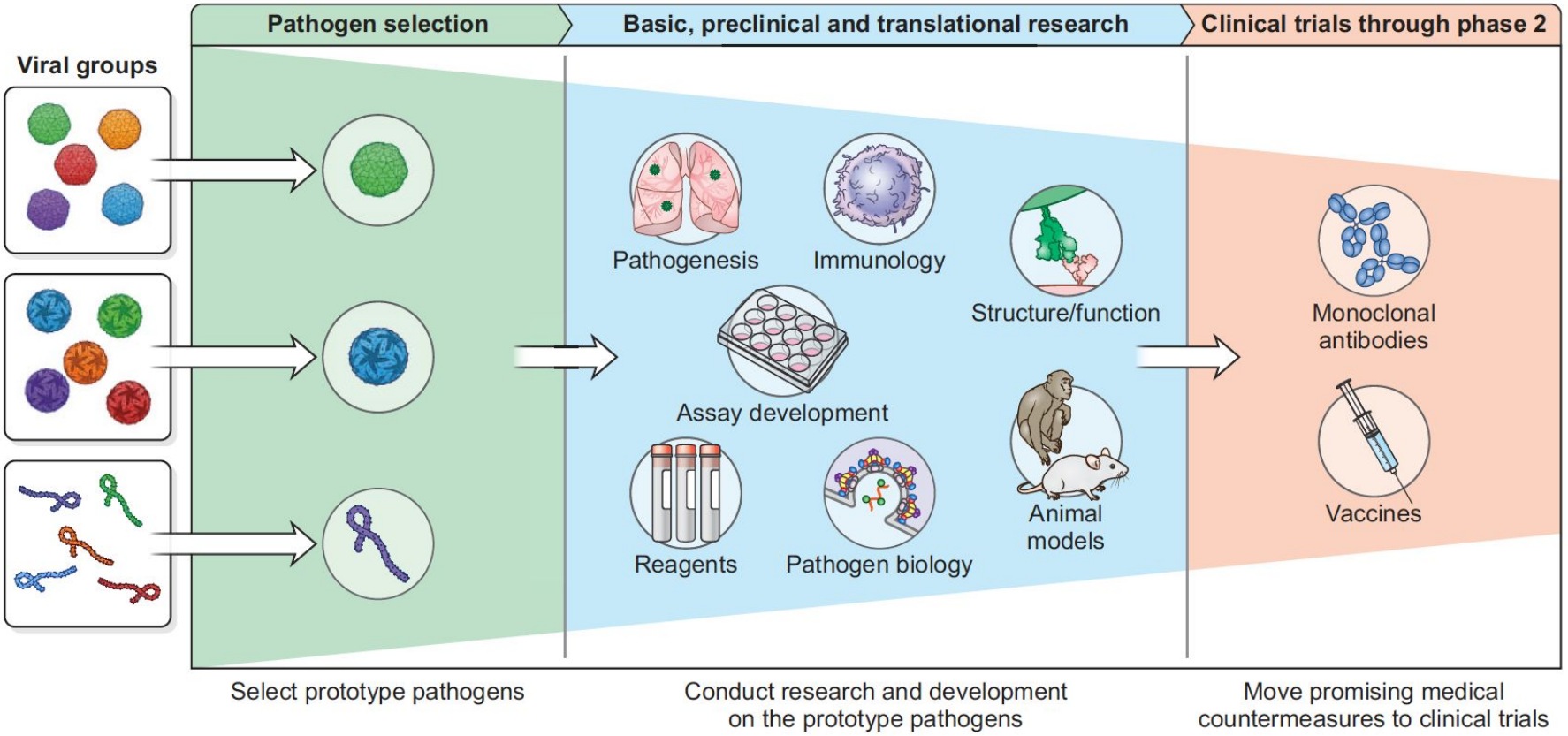
R.J. Noad et al. / Vaccine 37 (2019) 6241–6247

Pandemic Potential and Countermeasures: NIH



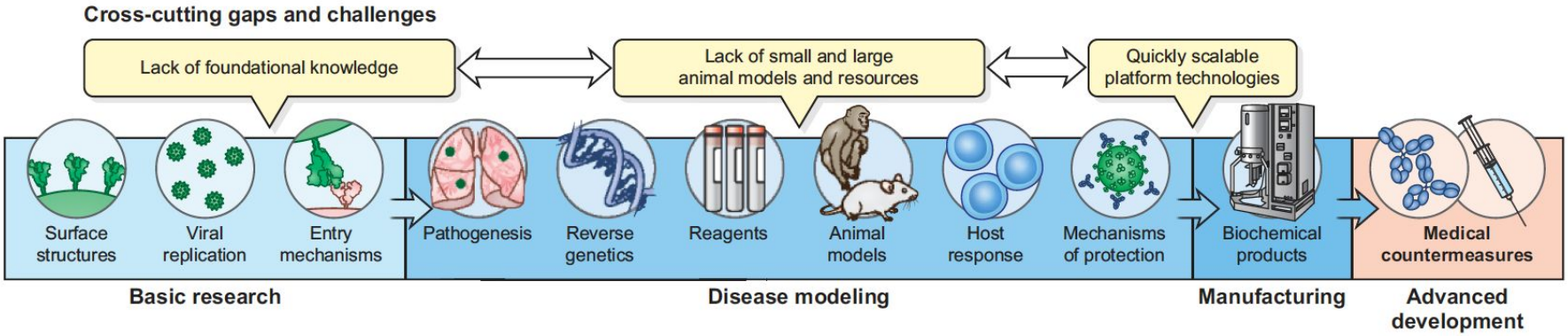
Cassetti et al J Infect Dis 2022

NIAID Prototype Pathogen Approach



Cassetti et al *J Infect Dis* 2022

Research Gaps



Cassetti et al *J Infect Dis* 2022

Strategy

- Steps to reduce the risk of spillover and the consequent introduction and spread of a new disease in humans;
- Improving disease surveillance in humans and animals, to rapidly detect and sequence the infectious agent;
- Strengthening research programs to shorten the time lag between the development and production of medical countermeasures;
- Rapid implementation of pharmaceutical and non-pharmaceutical measures, to contain a large-scale epidemic;
- Develop international protocols to ensure fair distribution and global coverage of drugs and vaccines

Mipantrini et al Eur J Public Health. 2022 Dec; 32(6): 841–842.

Antigen Identification

GISAID - Facilitating step-wise approach in antigen identification

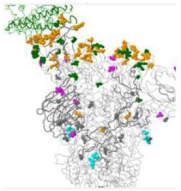
Disease X

Well characterized family?

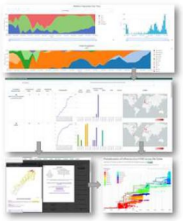
Yes

No

Pathogen-specific resources ← Rapid characterization

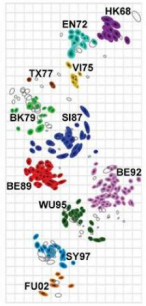


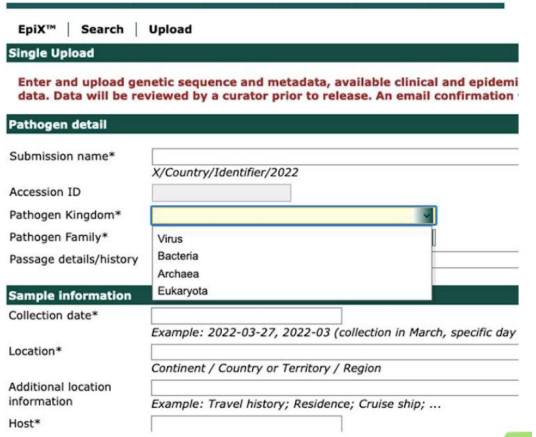
Compare to existing vaccine candidates and reference viruses



Monitor diversity and evolution of the virus

Iteration between computational prediction and experimental verification





Maurer-Stroh WHO R&D Blueprint presentation Jan 2024

Lessons from COVID-19 applied to Disease X

- Explore different vaccine platforms; need further research and development eg thermostability, delivery, dose-sparing and new technologies
- Broadly accessible adjuvants
- Distributed manufacture, sustainable production
- Regulatory engagement, flexibility, cross-reliance and collaboration
- Rapid sharing of data on sequences, animal models, immune responses
- International standards
- Clinical trials- coordinated multicentre trials

Adapted from WHO R&D blueprint meetings Jan 2024

Five areas of innovation needed to make CEPIs 100-day mission a reality

Rationale: It took only 326 days from release of the virus' genetic sequence to authorisation of a safe and effective vaccine

1. Creating a library of prototype vaccines for representative pathogens across multiple virus families
2. Getting clinical trials networks at the ready
3. Speeding up identification of immune response markers
4. Establishing global capacity to make top-quality, safe, and effective new vaccines quickly
5. Strengthening disease surveillance and global early-warning systems

https://cepi.net/news_cepi/

The WHO Collaborating Centre for Influenza

My Research Group at the Univ of Melbourne