novel coronavirus 2019

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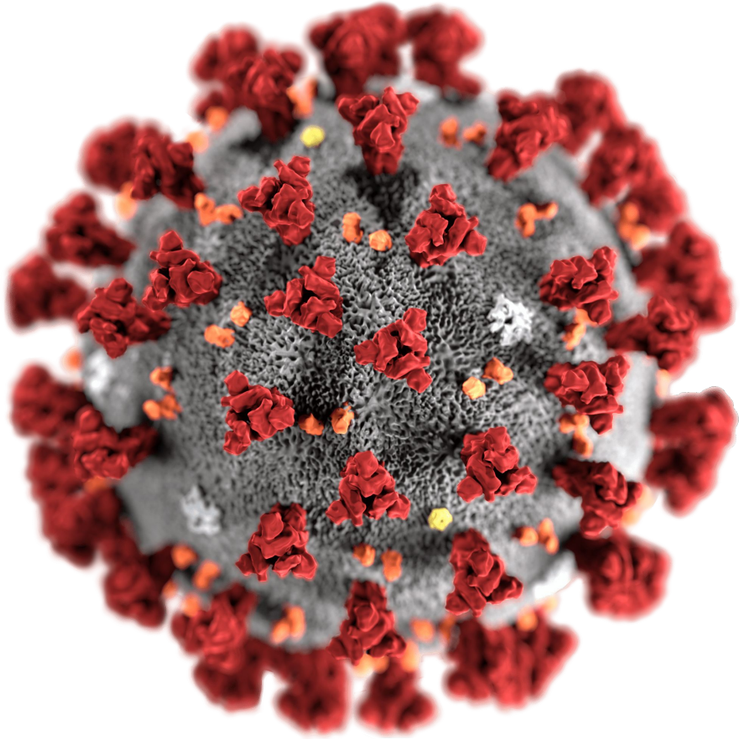
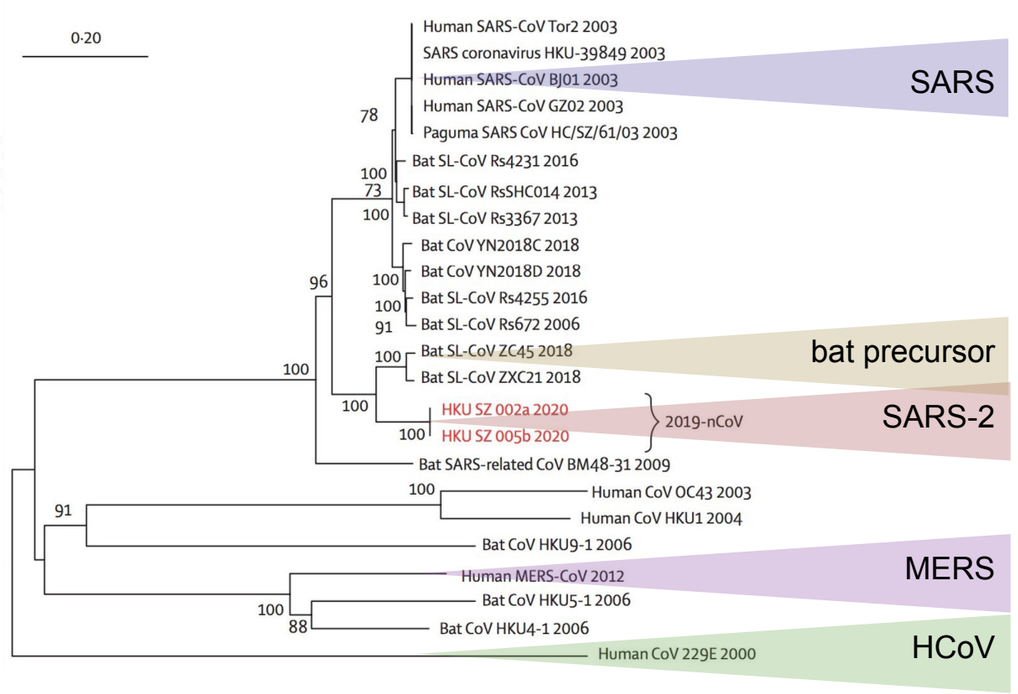
CALIFORNIA ACADEMY OF SCIENCES

What is it?

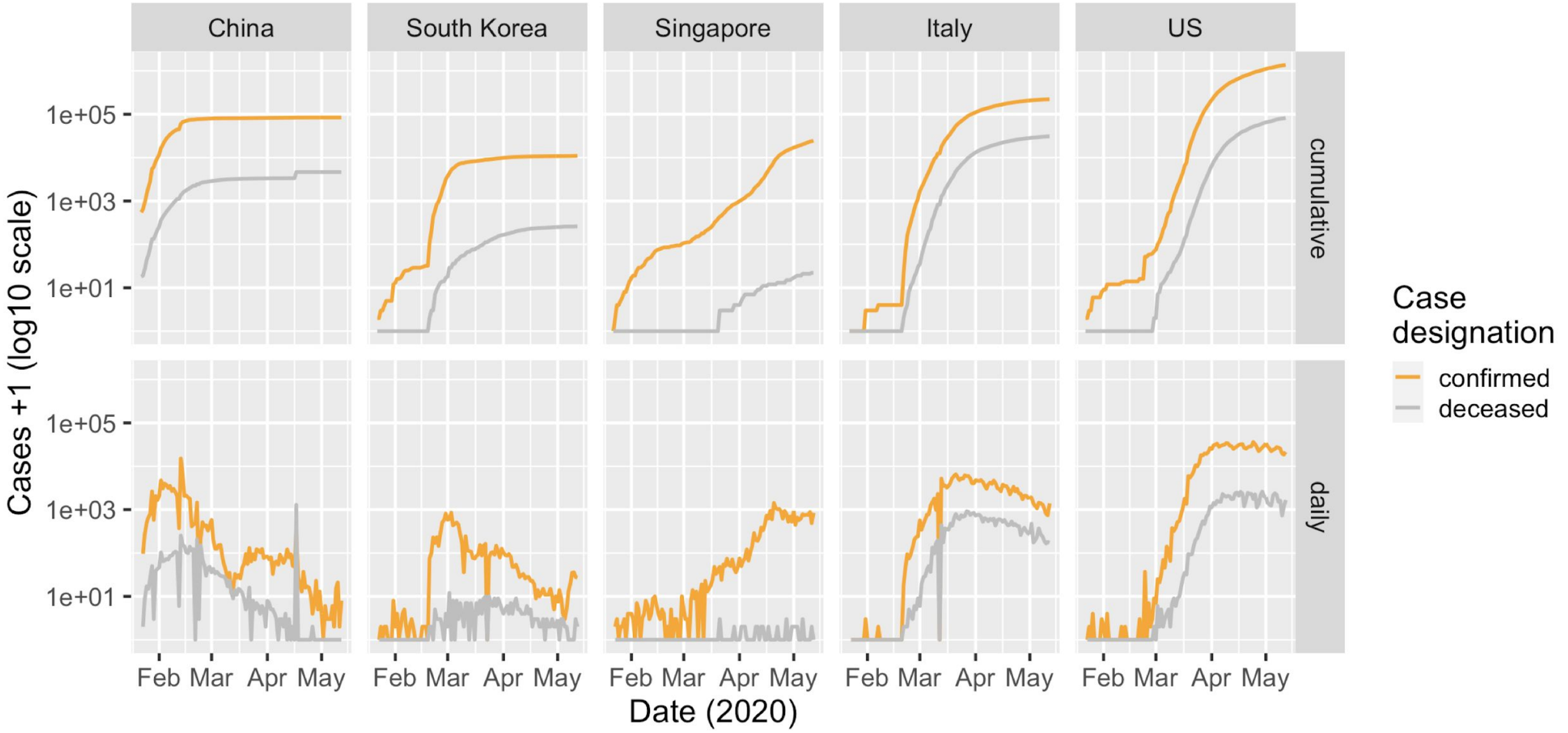
- Coronavirus
  - based on crown-like Spike proteins
  - related to SARS, MERS, and HCov strains
- Group infects a wide range of mammals
  - bats
  - palm civets (SARS)
  - camels (MERS)
  - humans (HCoV)
- Naming conventions
  - virus - SARS-CoV-2
  - disease - COVID-19





COVID-19

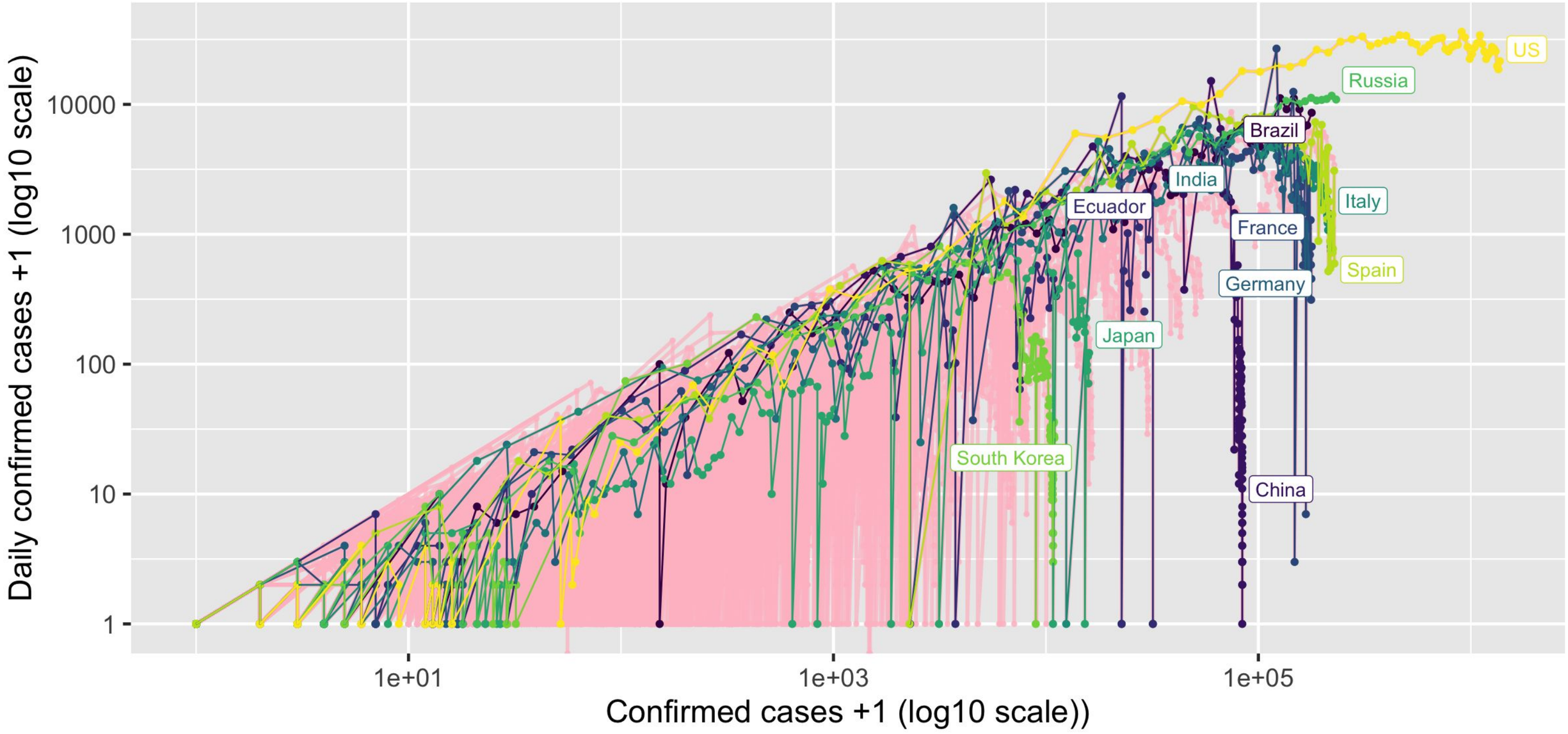
Cumulative versus daily case reports by case designation



Data source: https://github.com/CSSEGISandData/COVID-19 last downloaded Wed May 13 07:11:17 2020 PST

COVID-19

Confirmed versus Daily new confirmed cases



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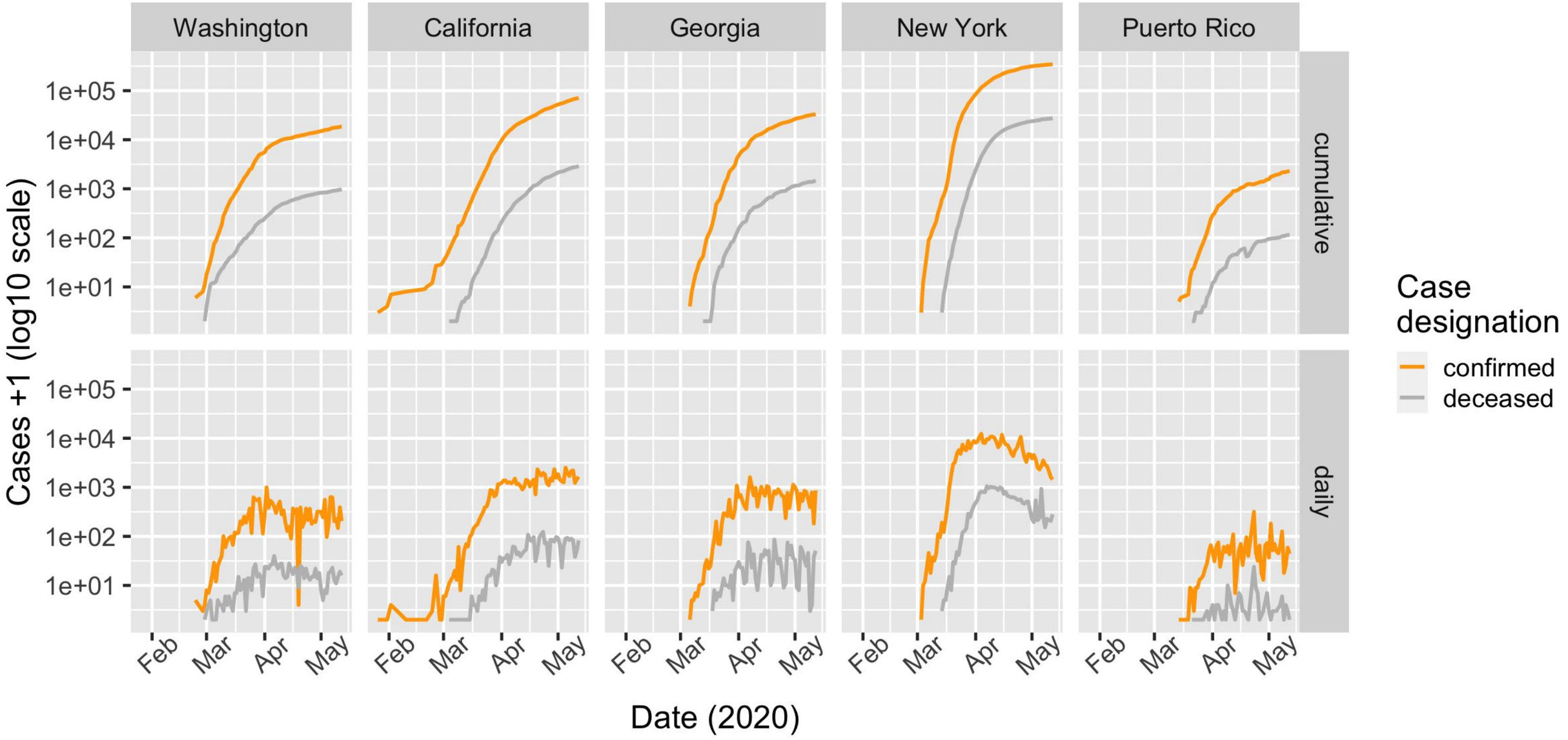
COVID-19

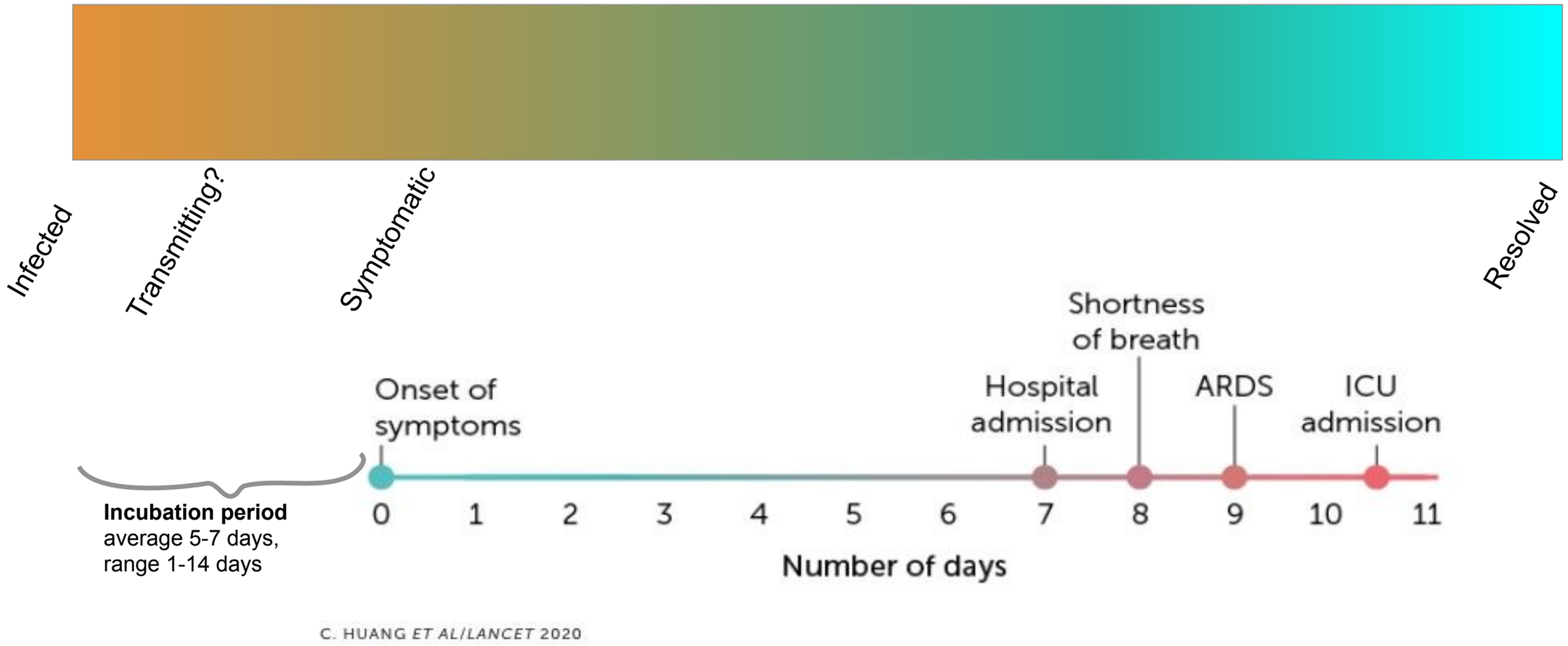
Case reports by case designation



source: https://raw.githubusercontent.com/nytimes/covid-19-data/master/ last downloaded Wed May 13 19:04:50 2020 PST


COVID-19
Case reports by case designation
Daily confirmed cases +1 (log10 scale)
10000
1000
100
10
10
100
1000
10000
100000
Confirmed cases +1 (log10 scale)
California
Texas
New York
Georgia
New Jersey
Louisiana
Washington
Puerto Rico
source: https://raw.githubusercontent.com/nytimes/covid-19-data/master/ last downloaded Wed May 13 18:44:08 2020 PST

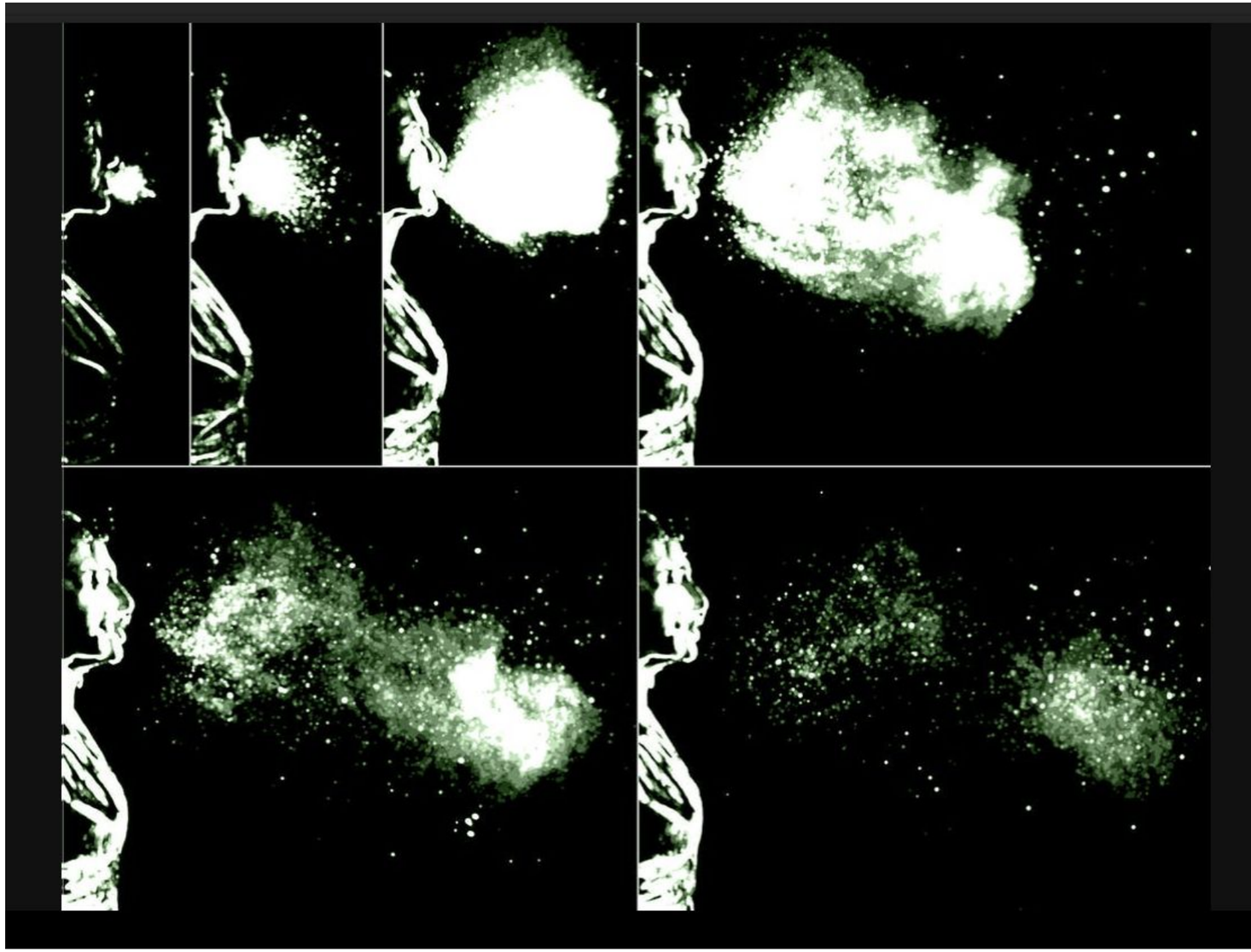
Course of infection



Incubation period: time between exposure and onset of sign or symptoms
Symptoms: fever (88%), dry cough (68%), fatigue (38%), sputum production (33%), shortness of breath (18%)...
Resolved: patient either recovers or passes; transmission ceases

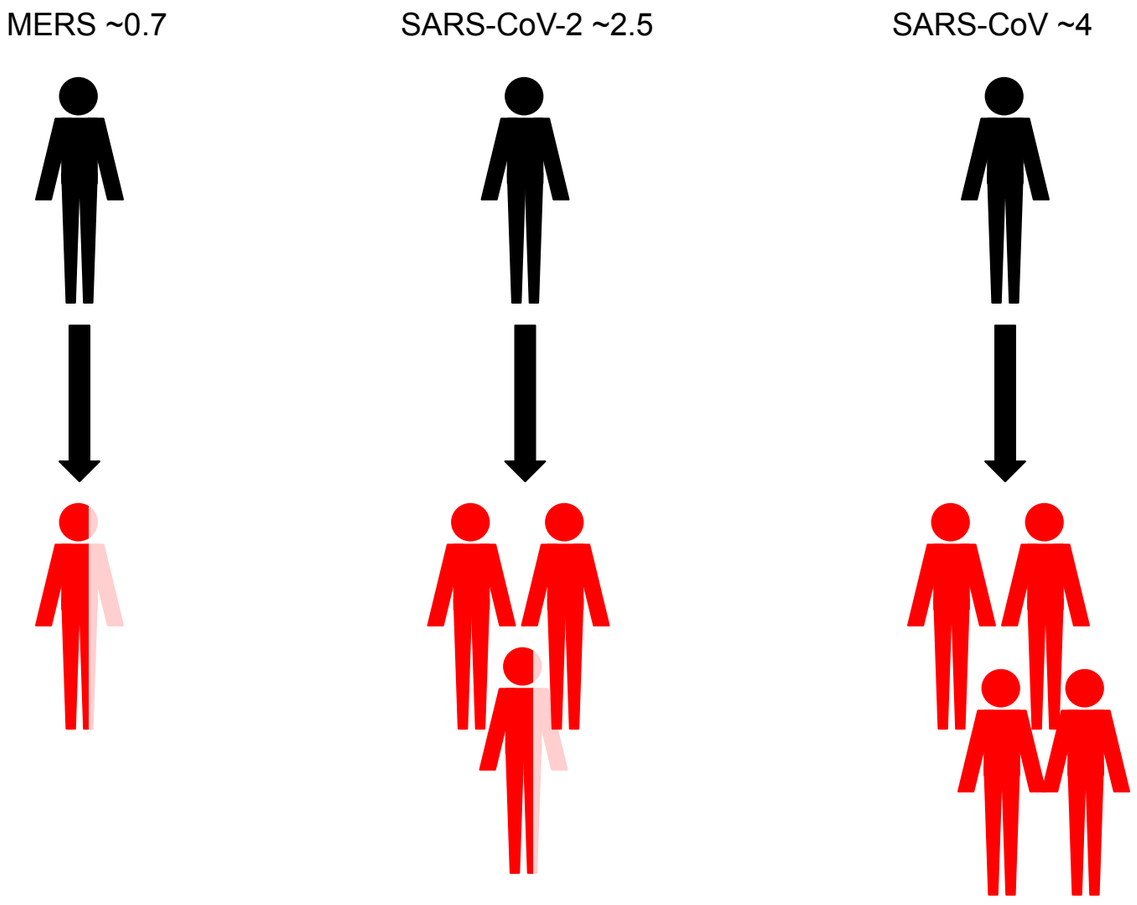
Modes of transmission

- Droplet
  - large respiratory droplets from coughs or sneezes
- Airborne
  - smaller droplets hanging in airspace
- Contact or fomites
  - virus-contaminated surfaces
- Direct
  - sharing mucous
- Fecal/oral
  - shed in feces



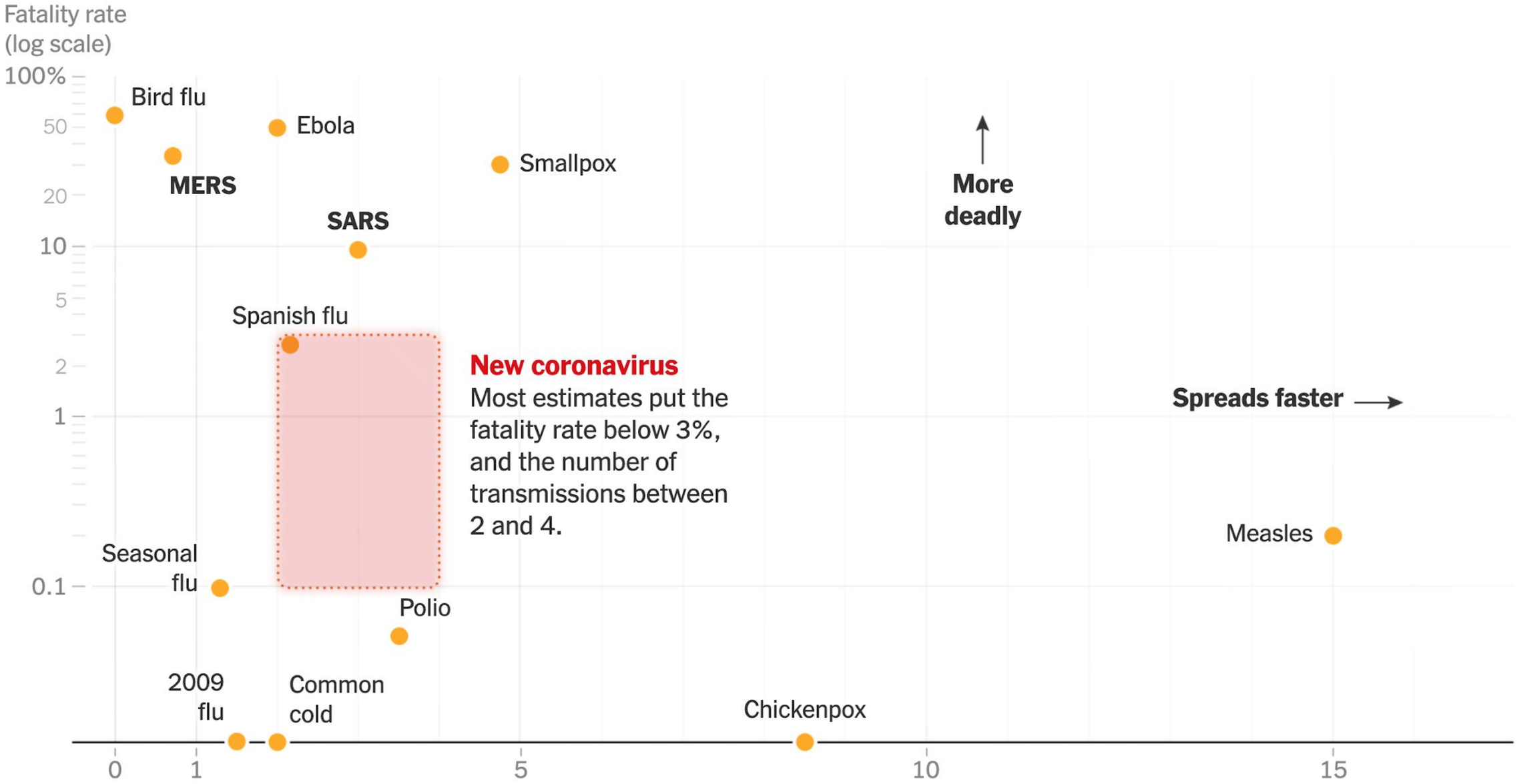
Bourouiba et al 2014 Journal of Fluid Mechanics v.745:537-563

Estimating parameters: Reproductive Number



Disease	**Transmission**	**R_0**
SARS-CoV-2	Airborne droplet	2 - 4
Measles	Airborne	12 - 18
HIV/AIDS	Sexual contact	2 - 5
H1N1 Swine flu	Airborne droplet	1.2 - 1.5
Rotavirus	Fecal-oral	16 - 25
SARS-CoV	Airborne droplet	2 - 5
MERS	Airborne droplet	0.7
Influenza (Seasonal)	Airborne droplet	0.9 - 1.8
Influenza (Spanish Flu 1918)	Airborne droplet	2 - 3
Ebola (2014 outbreak)	Bodily fluids	1.5 - 2.5
Zika	Mosquito-borne	3 - 6.6

Estimating parameters



New York Times summary 2020

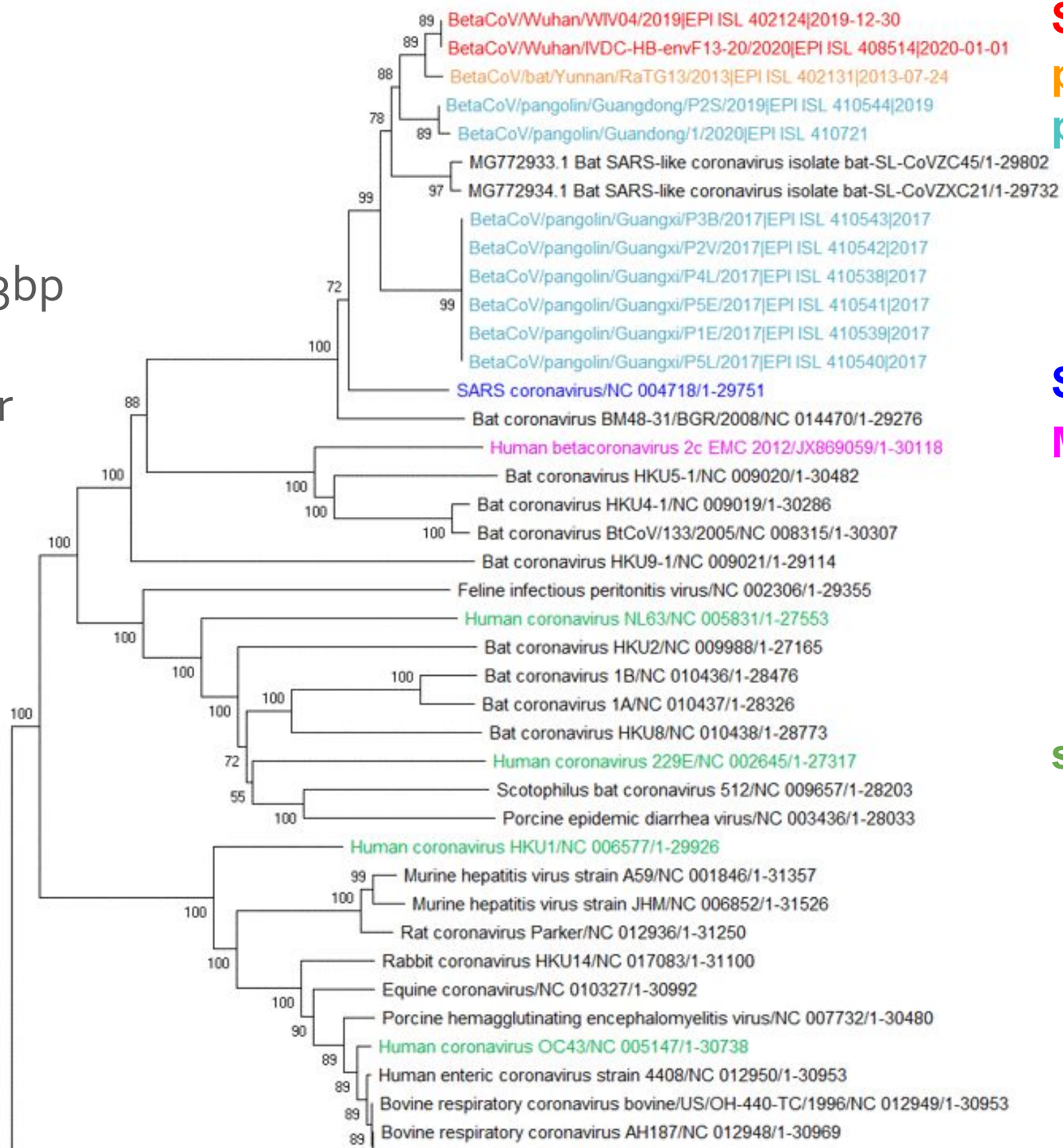
Crowd-sourcing the data and dashboards

- Johns Hopkins CSSE
- World-o-meter
- New York Times Tracker
- OurWorldinData
- ESRI Coronavirus storymap
- Common Operations dashboard
- Nextstrain
- GISAID

Evolution

+ssRNA virus:

- genome 29,903bp
- 10 genes
- 1-3 changes per month



SARS CoV-2

precursor, bat RaTG13 96%

pangolin, Guangdong 90%

SARS CoV 80%

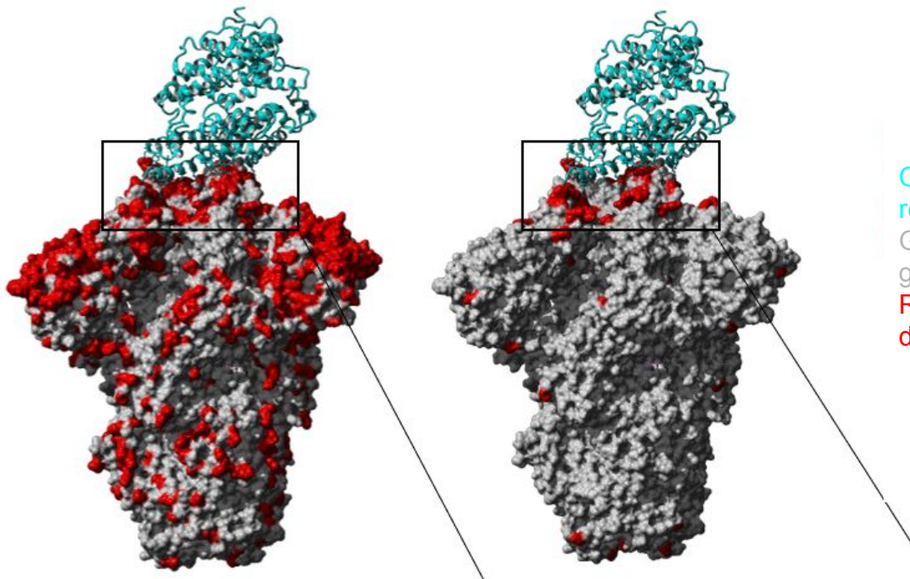
MERS CoV

seasonal HCov

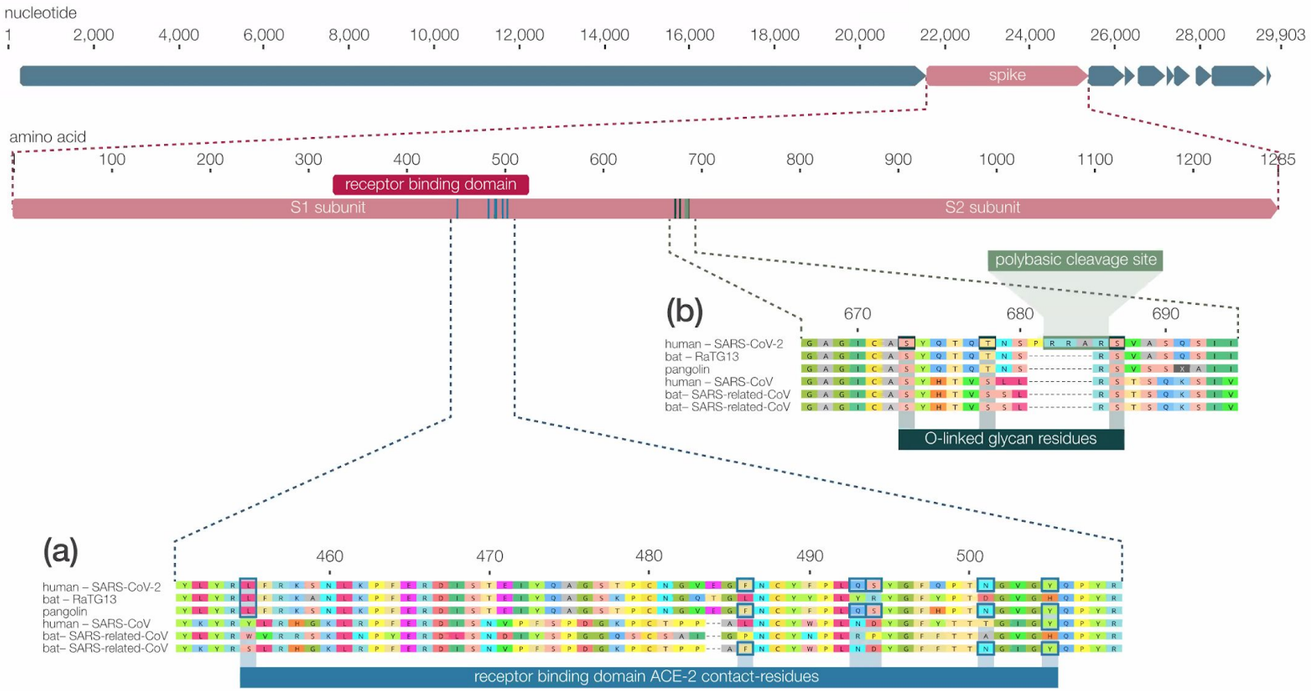
0.10 substitutions/site

GISAID.org

Evolution: Spike protein receptor binding site & furin cleavage site differences

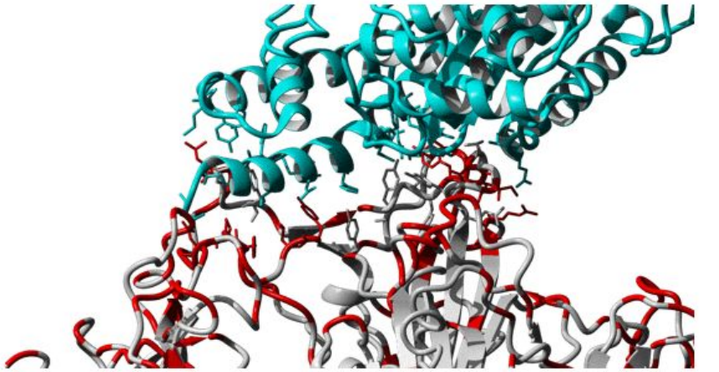


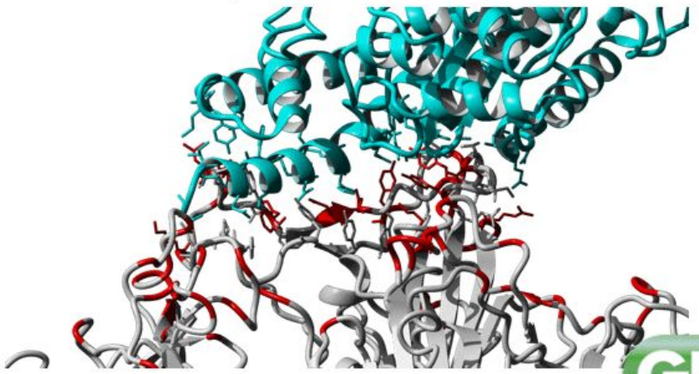
Cyan - ACE2 human receptor
Gray - CoV spike glycoprotein
Red - mutation differences



SARS vs hCoV-19

RaTG13 vs hCoV-19





We gratefully acknowledge the Authors from Originating and Submitting laboratories of sequence data on which the analysis is based.

by BII, A*STAR Singapore

GISAID

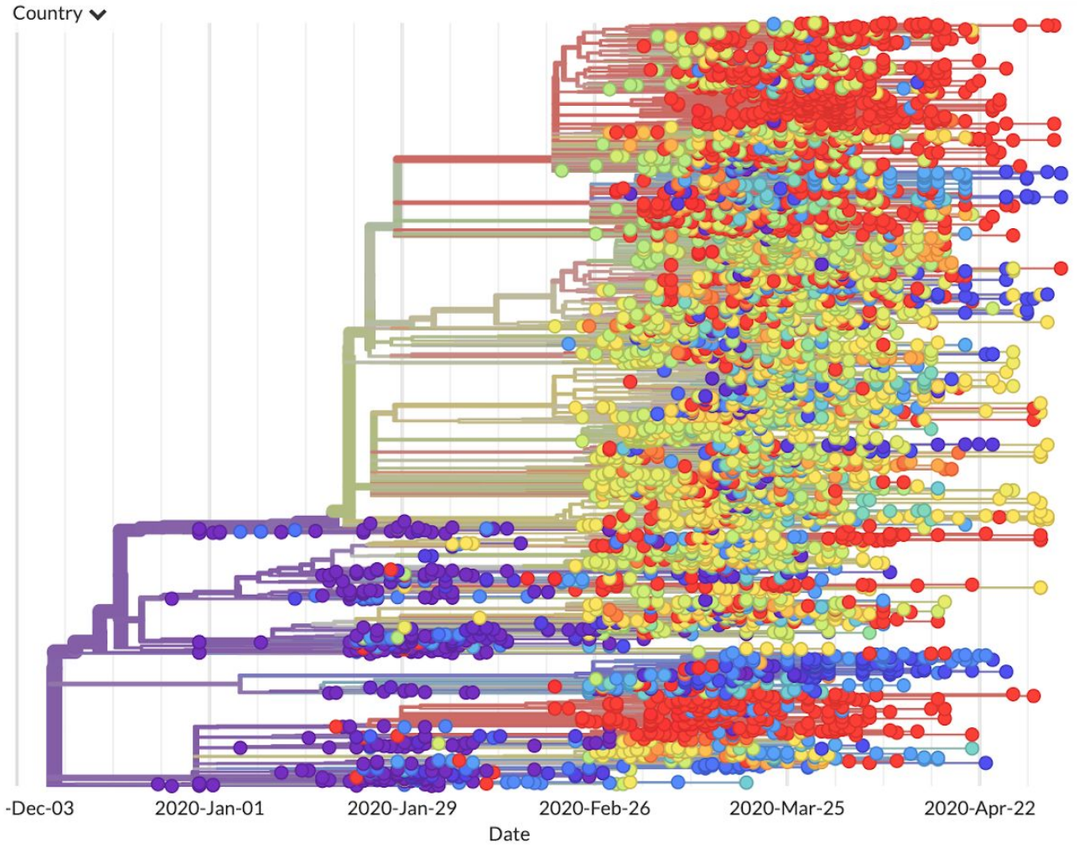
Genomic epidemiology of novel coronavirus - Global subsampling

Maintained by the Nextstrain team. Enabled by data from GISAID

Showing 5136 of 5136 genomes sampled between Dec 2019 and May 2020.

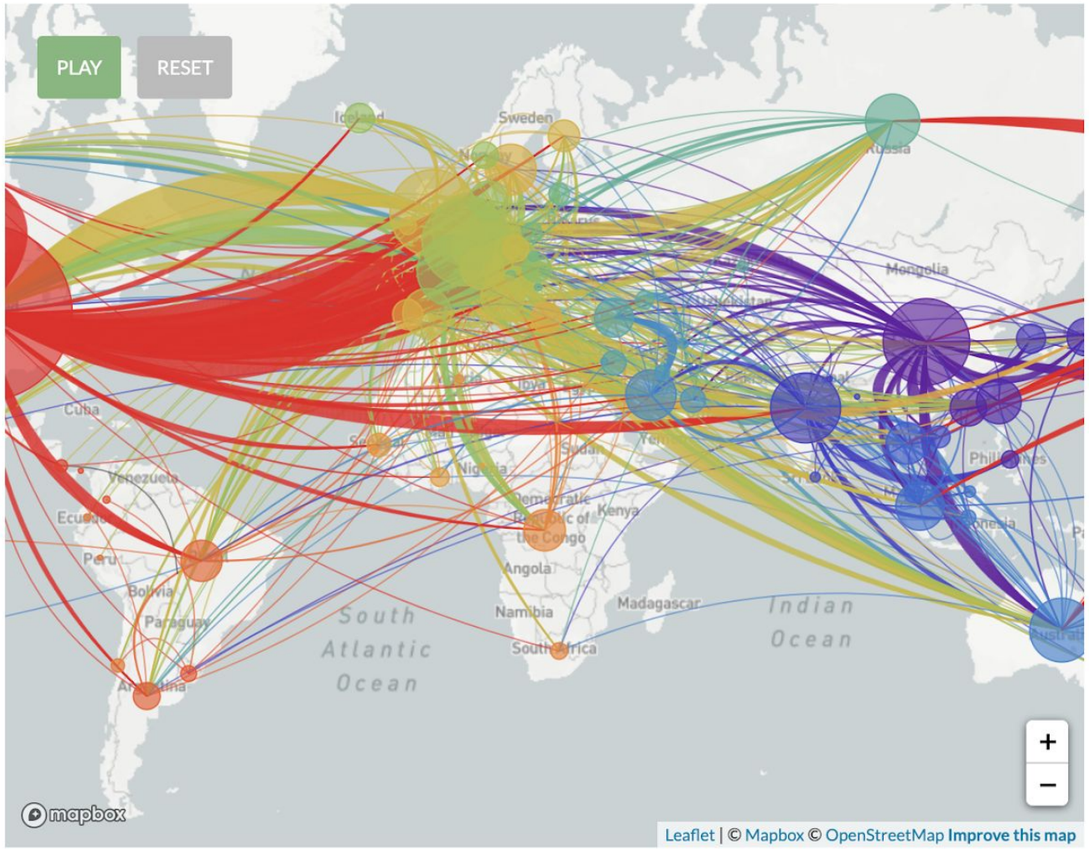
Phylogeny

RESET LAYOUT



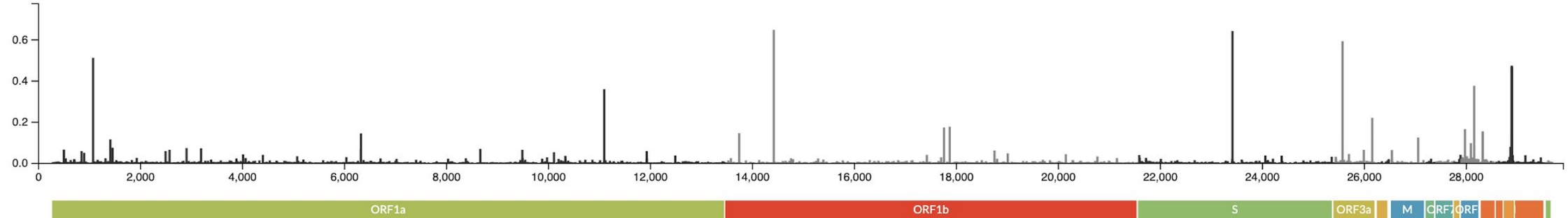
Transmissions

RESET ZOOM



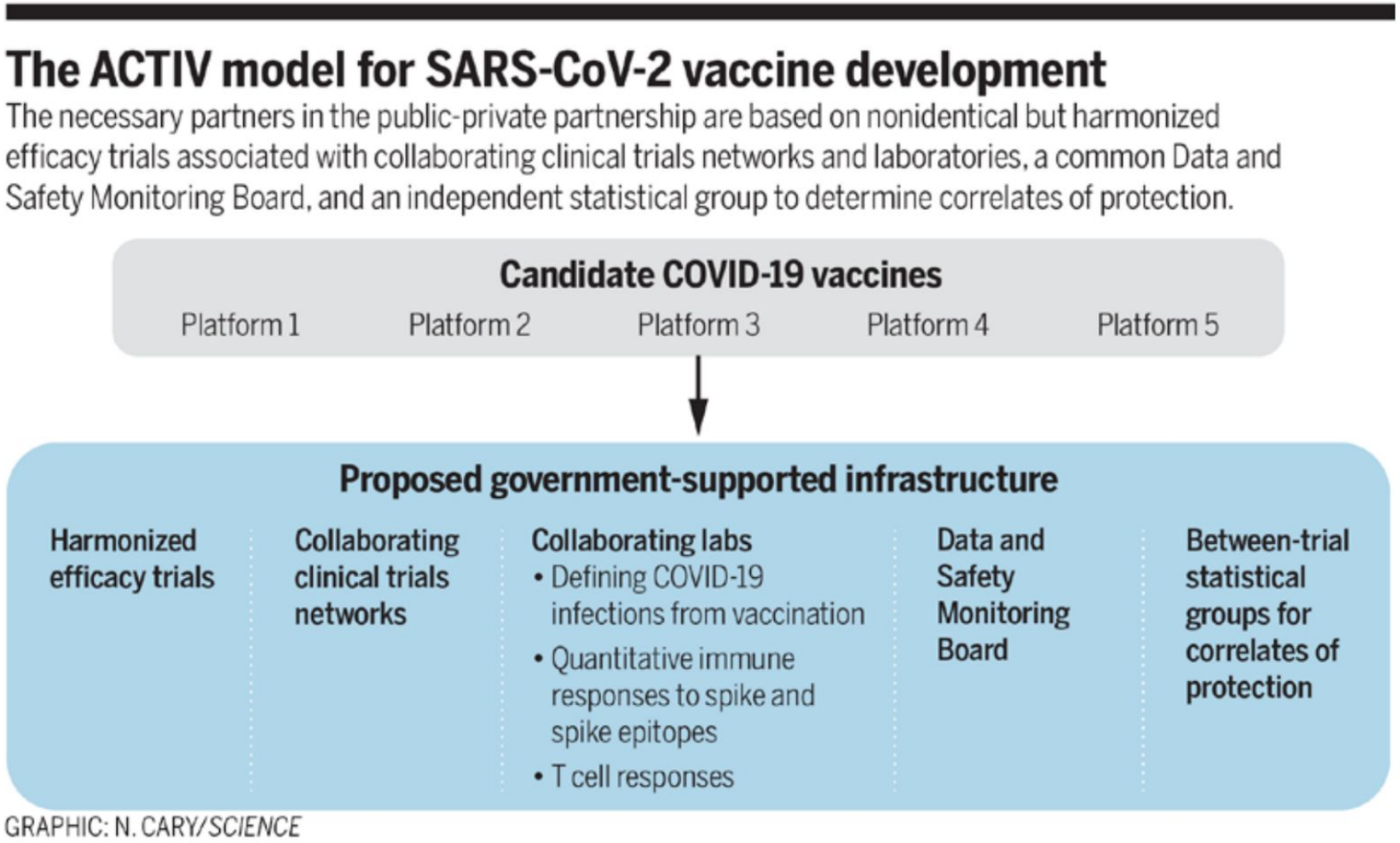
Diversity

ENTROPY EVENTS | AA NT



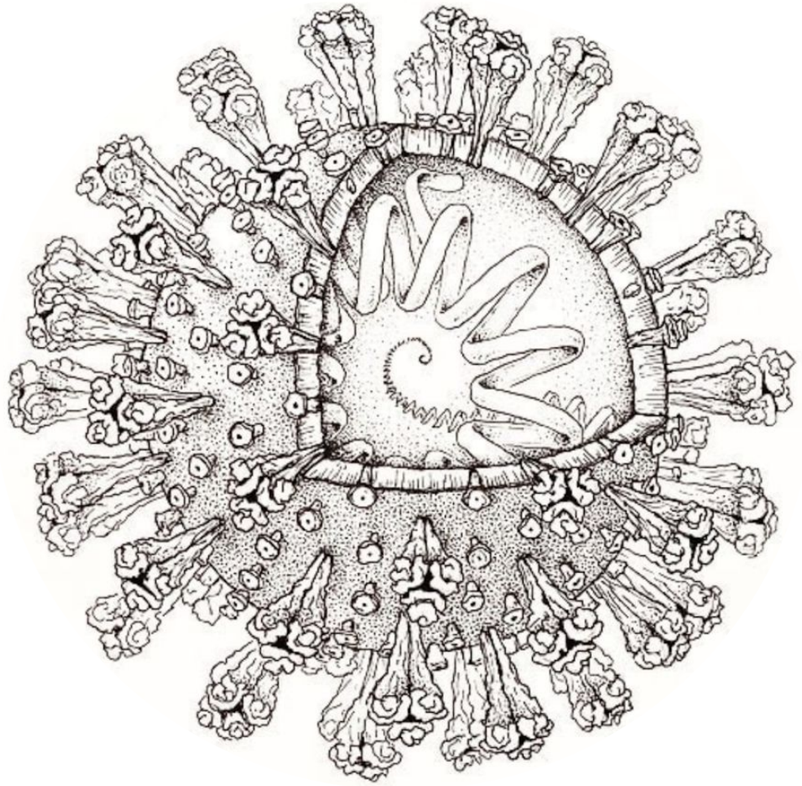
Vaccines - safety, efficacy, scalability

- traditional recombinant protein (e.g. flu vaccine)
- replicating & non-replicating viral vectors
- nucleic acid DNA and mRNA
- passive transfer of neutralizing antibodies



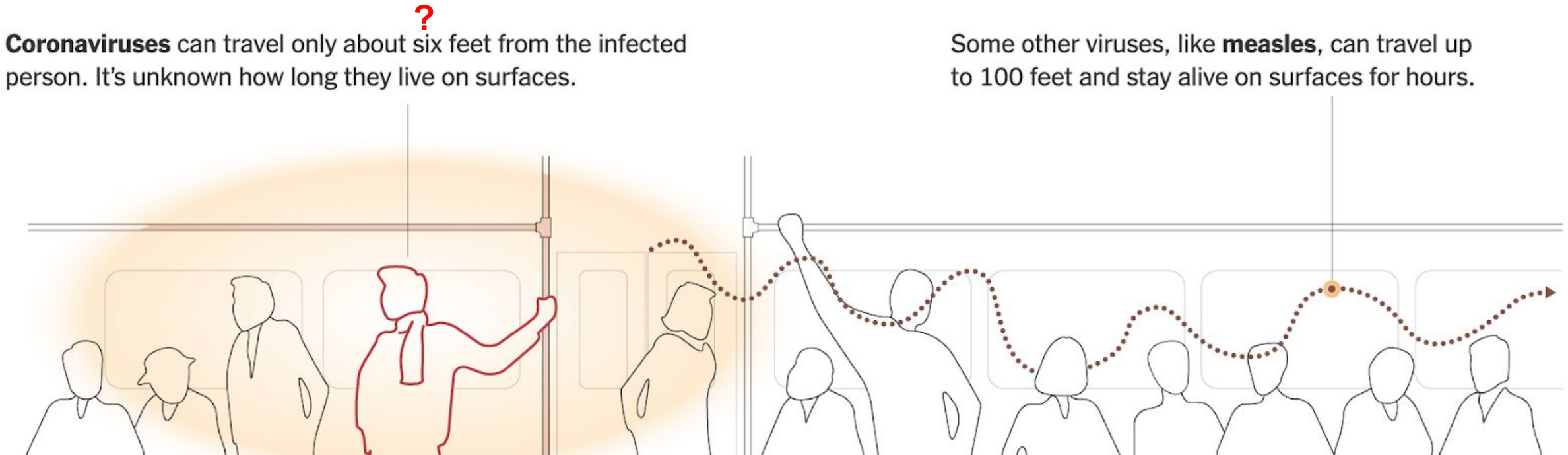
Therapeutics

- ~~Hydroxy , Chloroquine, and phosphate anti malaria drug also used to treat some autoimmune disorders (e.g., lupus)~~
- ~~Remdesivir – antiviral drug developed for Ebola~~
- Kaletra - Lopinavir and ritonavir drug combination approved to treat HIV, two alone or in combination with the flu drug oseltamivir (Tamiflu)
- Favipiravir - antiviral drug for the treatment of influenza
- ~~Arbidol antiviral~~
- Monoclonal antibodies
- Immunosuppressants

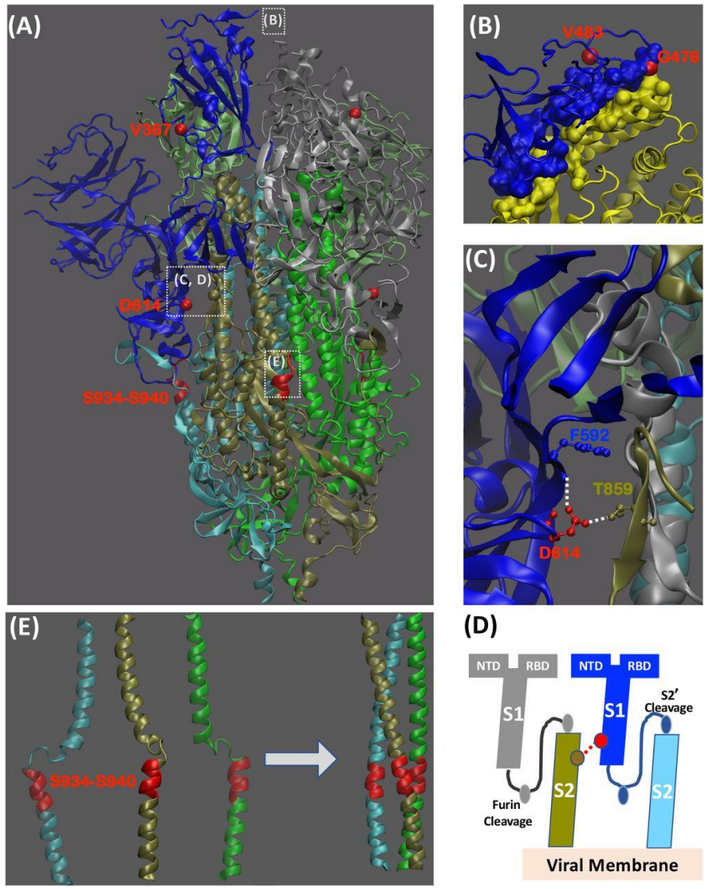


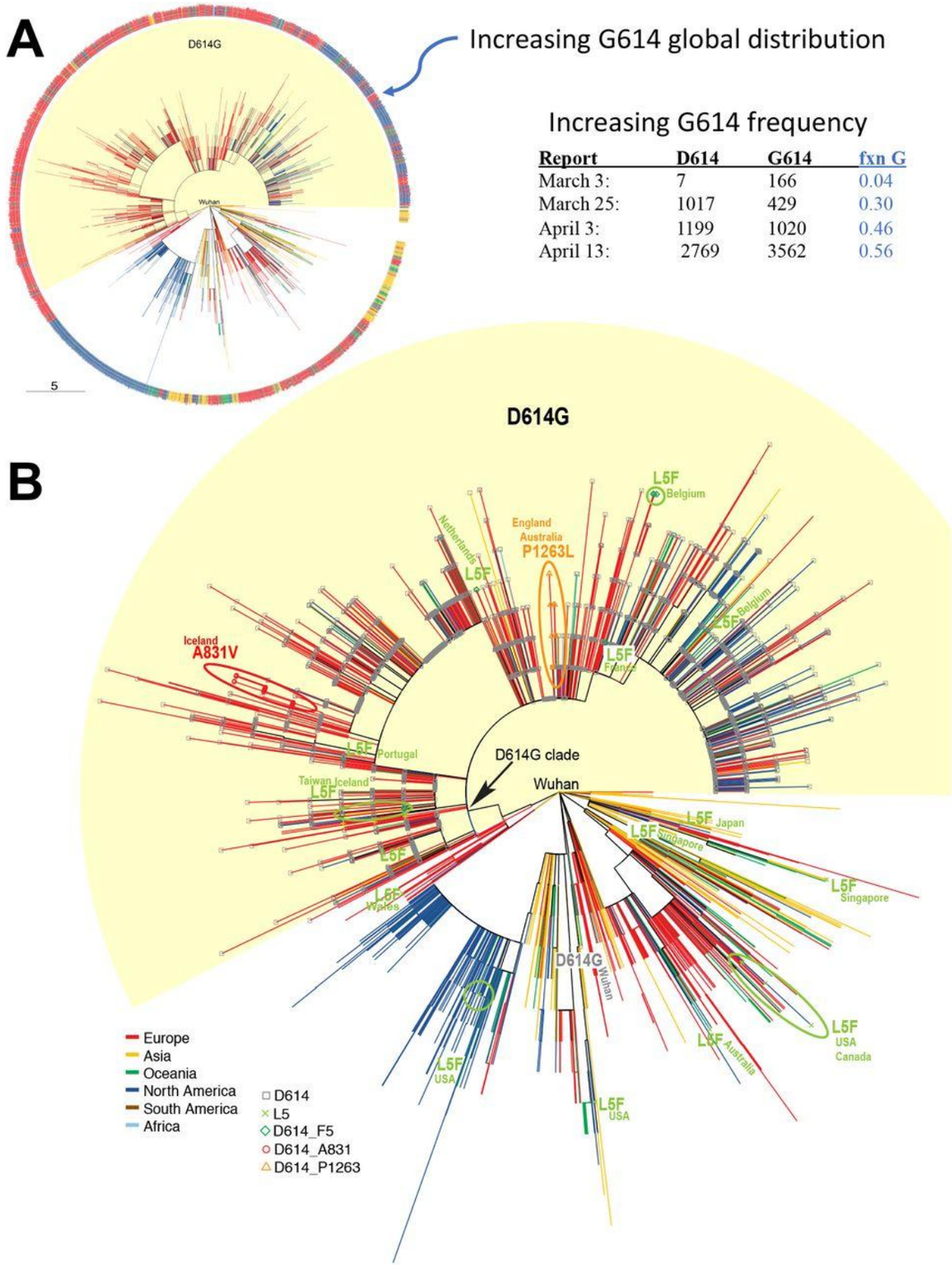
Updated Recommendations (CDC, WHO)

- Stay home if you are sick; stay home if you aren't sick (aka shelter-in-place)
- Wash hands often & thoroughly (20 s) with soap & water or alcohol-based (>60%) hand sanitizer
- Avoid touching face with unwashed hands
- practice social distancing
- Where a cloth face covering where it is difficult to maintain social distance



Evolution: G lineage Spike protein mutation D614G





Spike mutation pipeline reveals the emergence of a more transmissible form of SARS-CoV-2

B Korber, WM Fischer, S Gnanakaran, H Yoon, J Theiler, W Abfalterer, B Foley, EE Giorgi, T Bhattacharya, MD Parker, DG Partridge, CM Evans, TM Freeman, TI de Silva, on behalf of the Sheffield COVID-19 Genomics Group, CC LaBranche, DC Montefiori

bioRxiv 2020.04.29.069054; doi: https://doi.org/10.1101/2020.04.29.069054