Innovations in diagnostics help contain COVID-19 spread and expedite economic recovery

創新診斷科技幫助遏止新冠肺炎散播和加速經濟復甦

Prof Joseph Tam
Dr HY Poon
JT Technology & Consultant Ltd

JT TECH COMPANY MISSION & HOW IT GOES

Mission and Objective

- To promote biotech development in HK by supporting startups

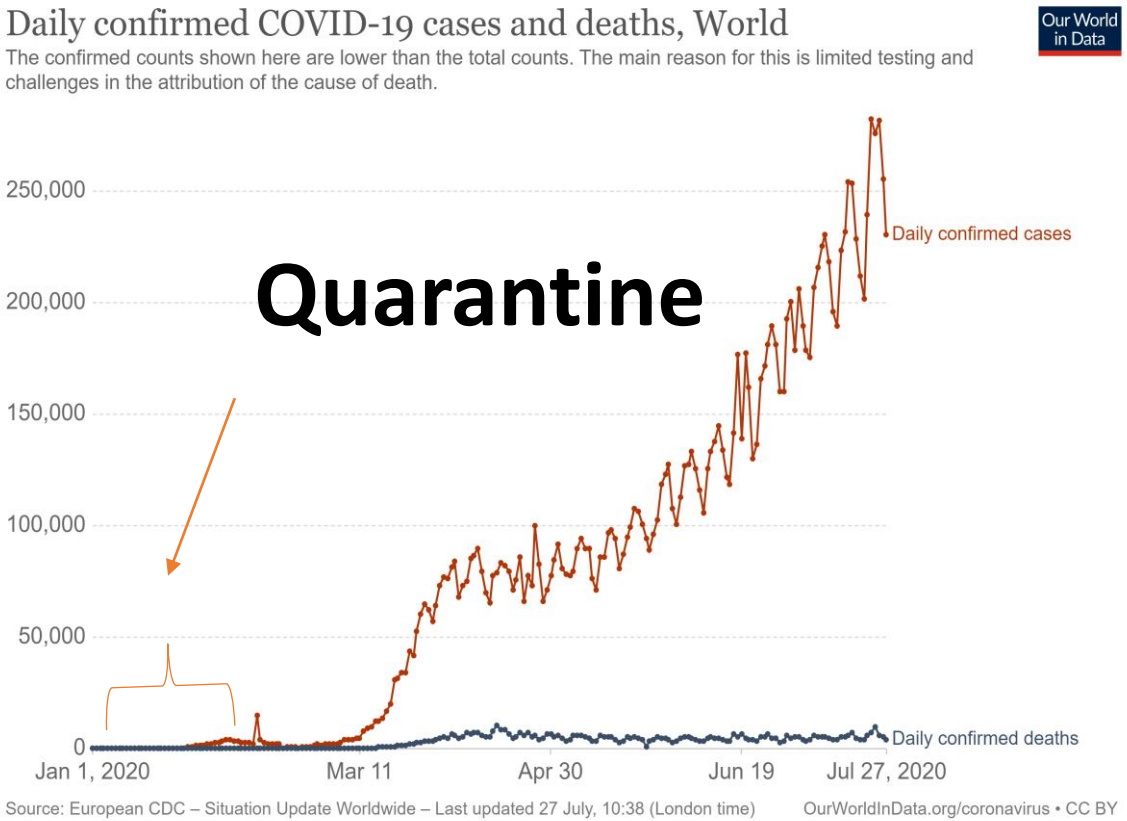
- We believe in disease prevention hence focus in the areas of diagnostics and related technologies- starting from founding HybriBio to DiagCor and Pangenia

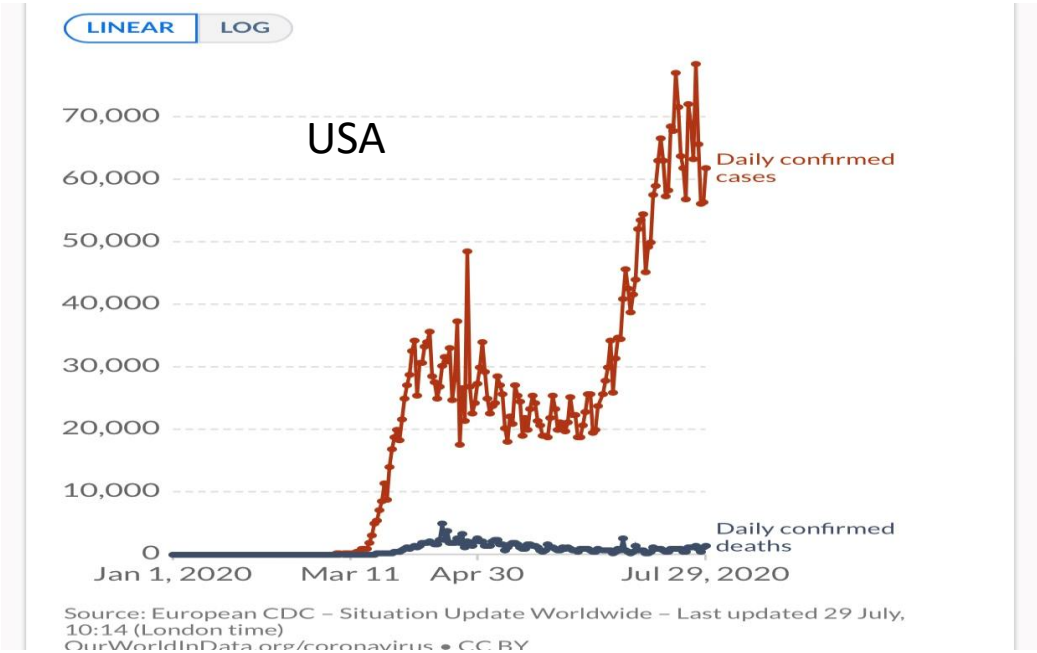
COMPANY MISSION & HOW IT GOES

Portfolio Company (Seed funding and advisory)

- **Phase Scientific** – Sample isolation platform
- **ThunderBio** – Microfluidic digital PCR and platform
- **AUISET** – AIE based LFI
- **Qi Diagnostics** – VOC detection for disease and healthcare
- **OM Sciences** – Next Generation Spirometer & unique sensor with wide applications
- **Arbele** – Diagnostic and novel cancer therapeutics
- **Myoceo (Pangenia Subsidiary)**– Orphan drug (rare diseases, genomic extension)

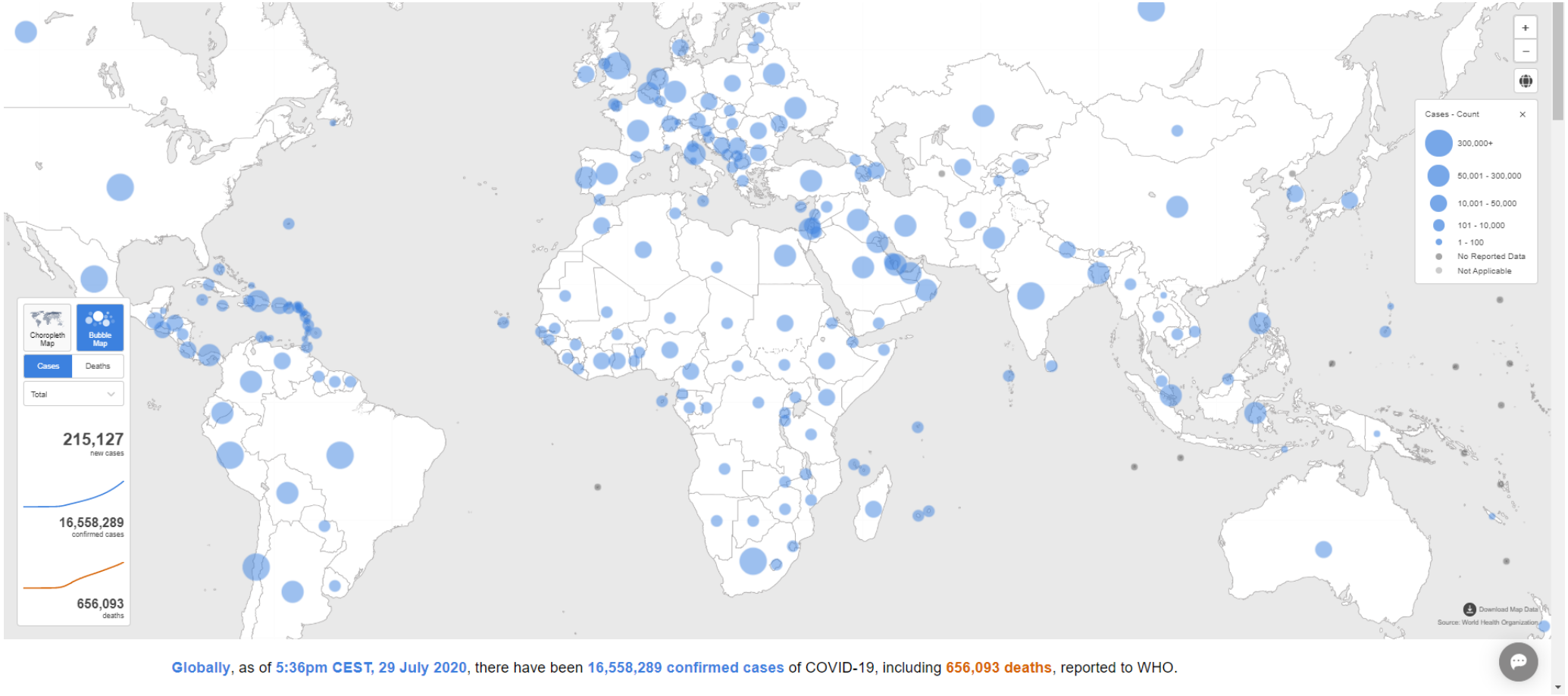
TESTING IS THE KEY TO CONTAIN SARS-COV-2 & ECONOMIC RECOVERY





Source: https://ourworldindata.org/grapher/daily-covid-cases-deaths/

CURRENT STATUS OF COVID PANDEMIC



Source: https://covid19.who.int/

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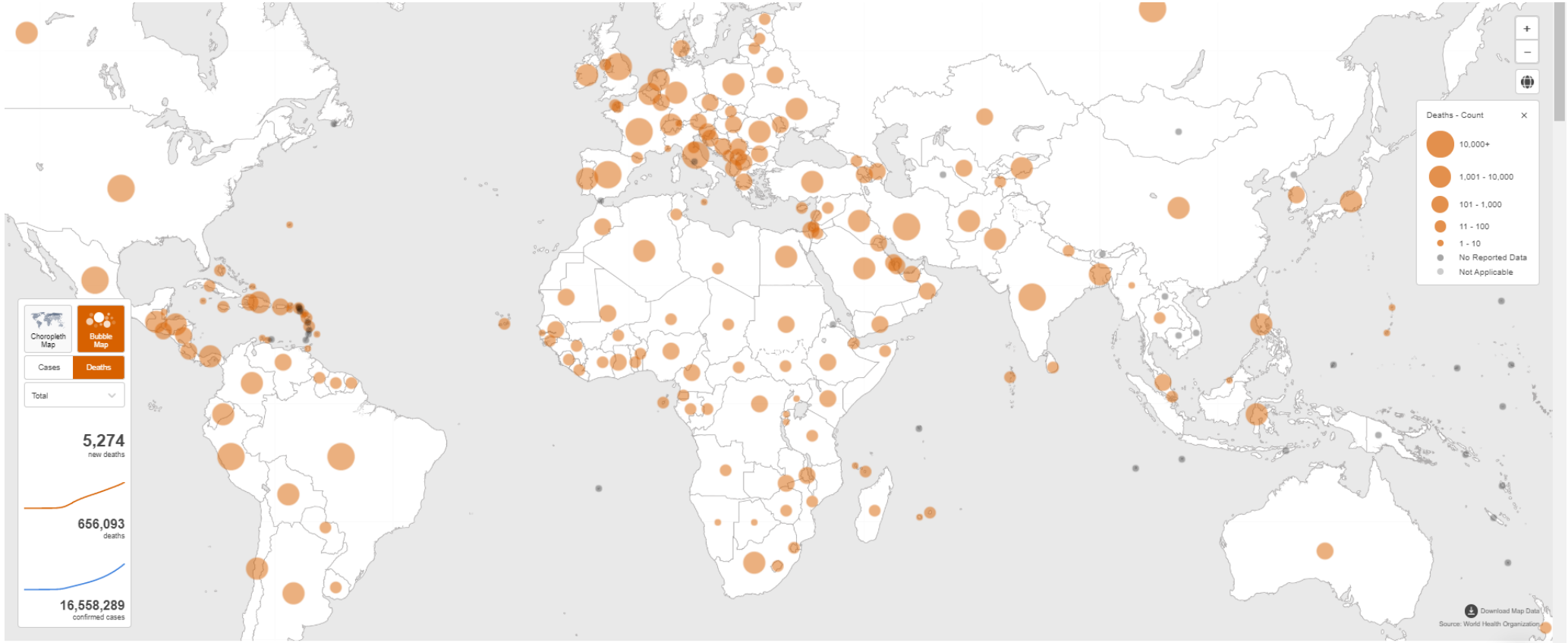

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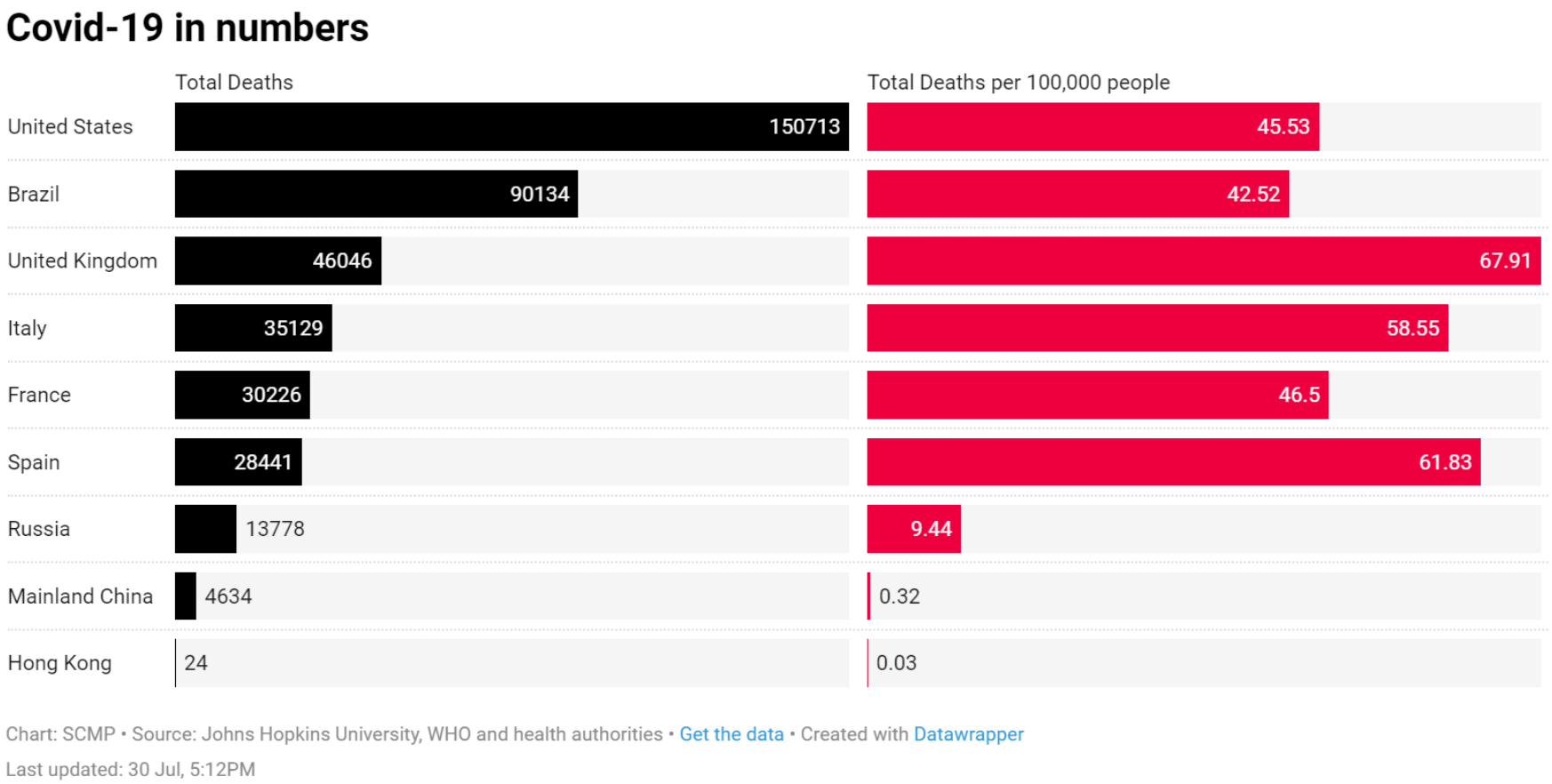
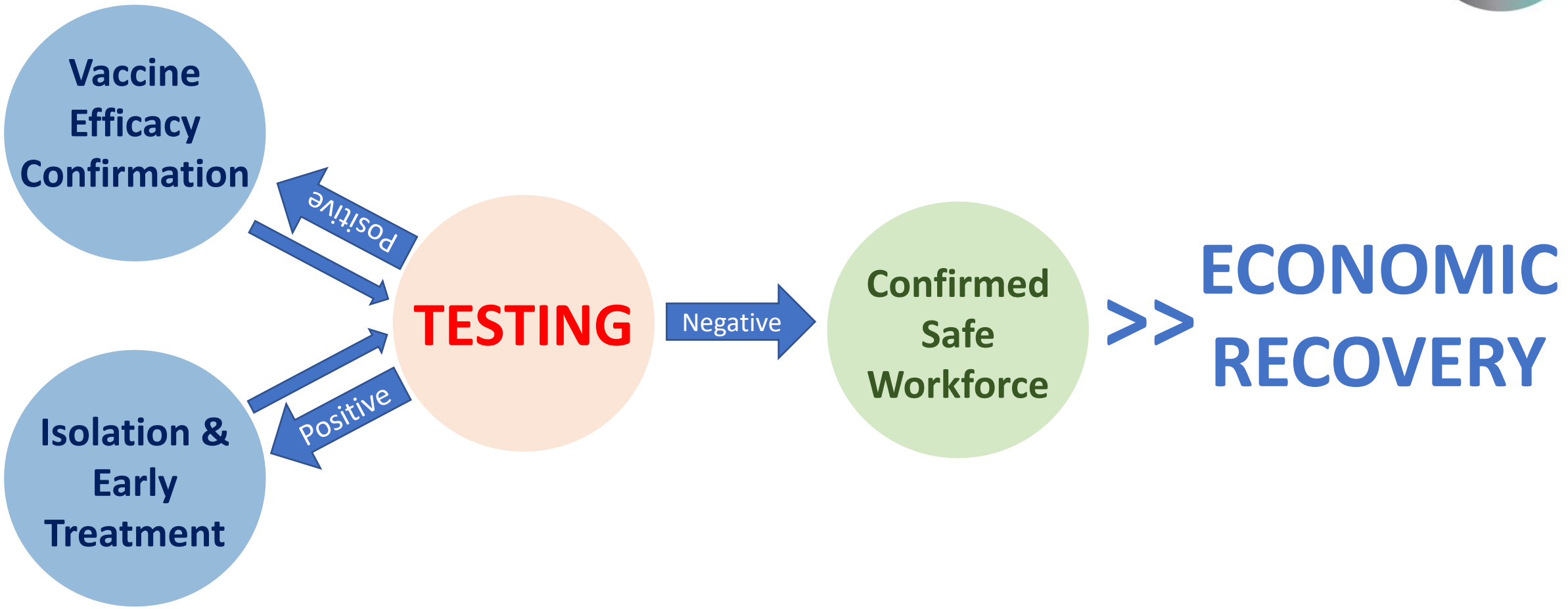


Source: https://www.scmp.com/coronavirus

TESTING AND ECONOMIC RECOVERY



STRATEGY FOR CONTAINMENT & RECOVERY

Prevention

1. Containment – Isolation
2. Diagnosis
   a) Fast & Accurate Screening
   b) Diagnosis - Comprehensive
3. Vaccination (Efficacy & Time)

Treatment

Early Treatments

- Hydroxychloroqine
- Remdesivir
- Cocktail formula
- TCM etc.

Recovery – Diagnosis / Screening is First & Key

>> Isolation & Early Treatment

>> Vaccination needs diagnosis to confirm efficacy

>> To certify SARs-Cov-2 negativity to ensure workforce safety

STRATEGY THAT WORKS IN PANDEMIC

	Population	Testing Scheme	Tests (%)	Confirmed Cases (%)	Deaths	Death Rate	Avg Age
Lombardy	10.1 M	Significant Symptoms	607,863 (6.04%)	85,775 (0.85%)	15,600	18.2%	45.4
Veneto	4.9 M	Active Surveillance / Screening	536,798 (10.94%)	19,030 (0.39%)	1,800	9.5%	45.1
Indonesia	267.7 M	Significant Symptoms	50,000 (0.019%)	57,770 (0.0216%)	2,934	5.1%	30.5
Vietnam	95.8 M	High Screening Isolation	>200,000 (0.21%)	355 (0.00037%)	0	0%	30.9
New York	19.4 M	Close on 17-Mar	17-Mar	412,000 (2.17%)	32187	7.8%	34.2
California	39.5 M	Close on 25-Feb	25-Feb	389,000 (0.98%)	7697	2.0%	36.7
Hong Kong	7.5 M	Active Surveillance	Data not available	1,886 (0.025%)	12	0.6%	44.8
Korea	51.6 M	Full Surveillance	1,200,000 (2.33%)	13,771 (0.027%)	296	2.2%	40.8

SUMMARY OF OBSERVATION

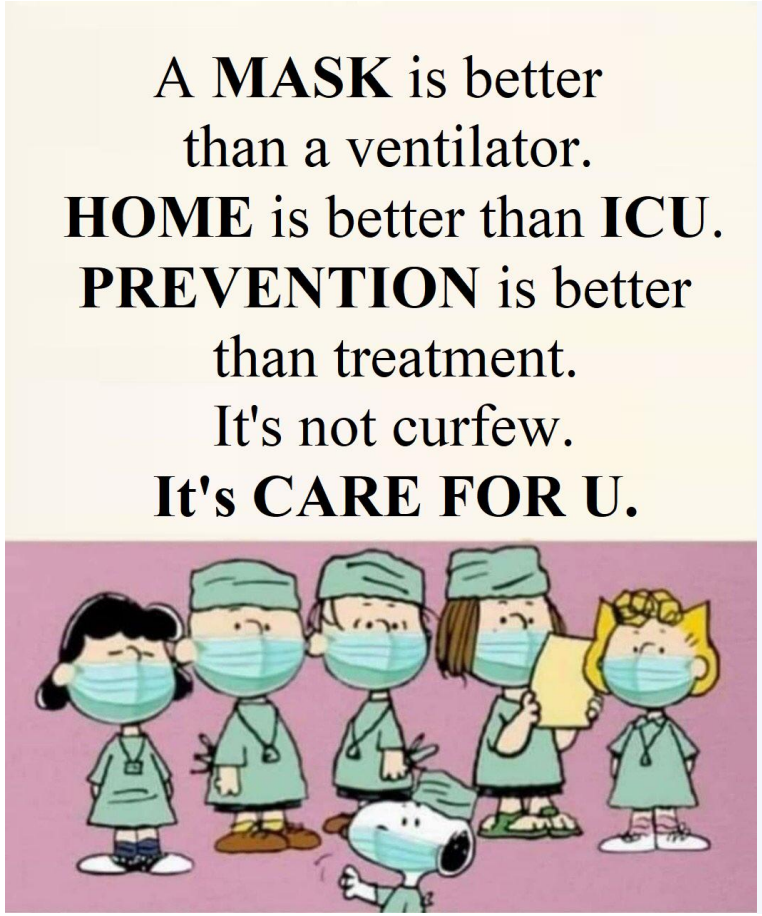
1. The early screening to identify the virus that can enable effective isolation: Germany; Taiwan, Macau, Vietnam
2. Extensive Surveillance Screening Testing: Korea; Veneto; Vietnam and Hong Kong
3. Isolation: China; Taiwan, Vietnam and (California vs New York)
4. Personal Hygiene: Face covering and social distancing:

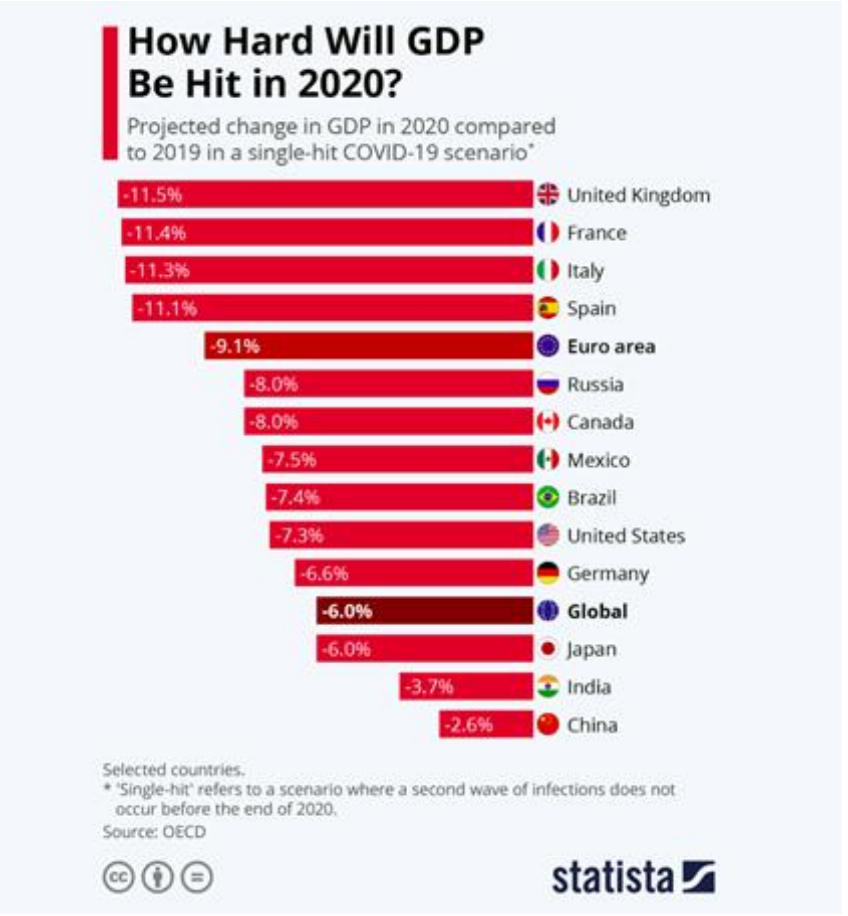
   Asian Vs Western: Need Education & Self Discipline

Test to identify COVID => Isolation & early treatment

Isolation and strict personal hygiene prevent spread

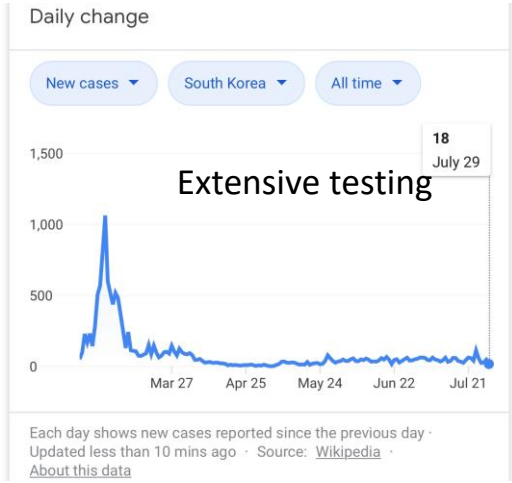
STRATEGY FOR CONTAINMENT & RECOVERY



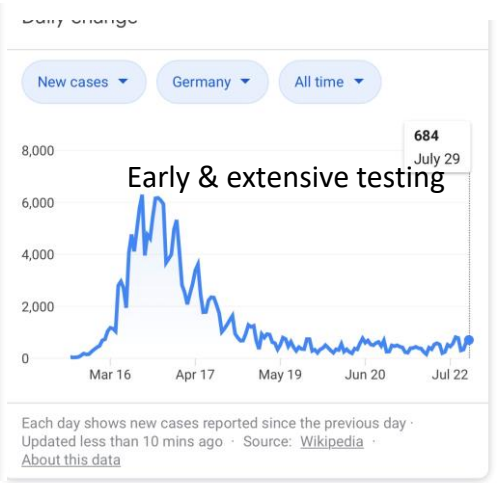


Source: cannot find original citation

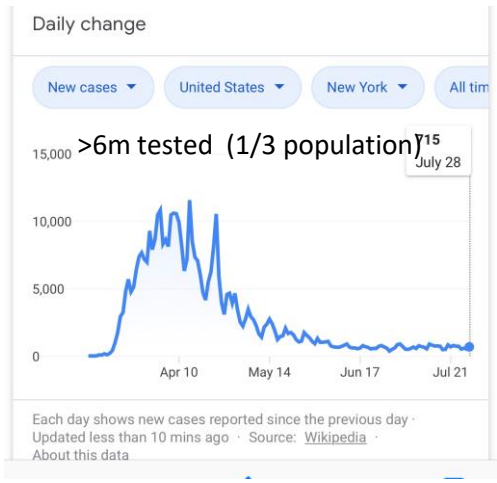
https://www.statista.com/chart/21961/oecd-gdp-growth-projections-2020-on-2019



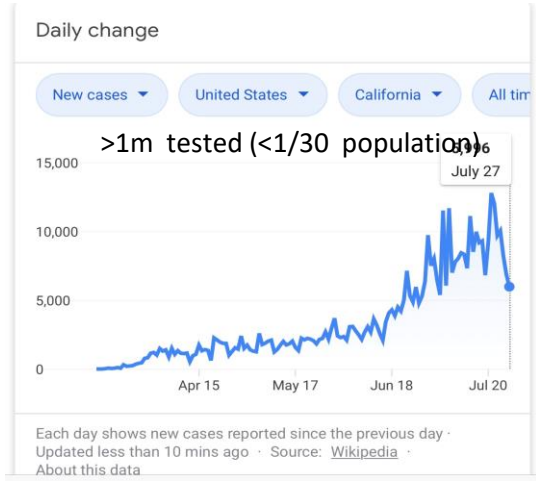
Extensive testing



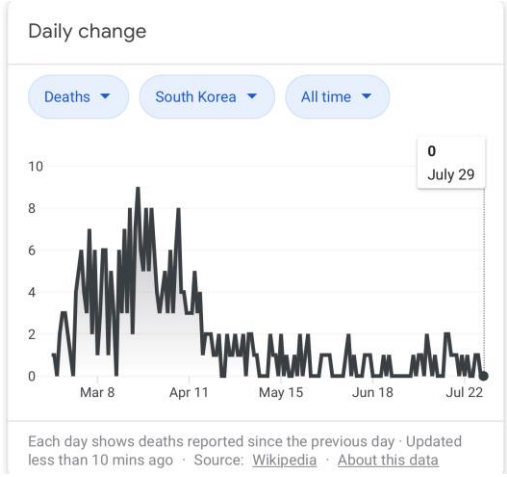
Early & extensive testing

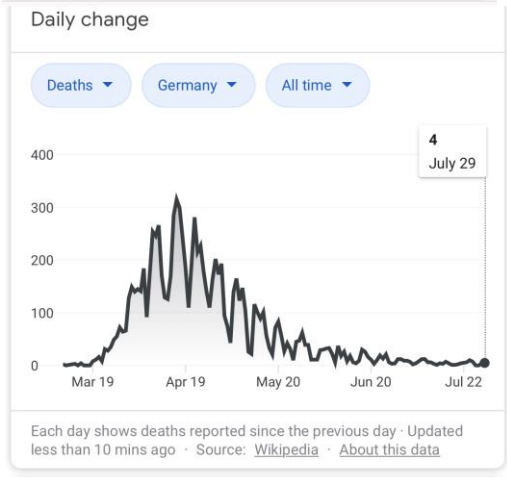


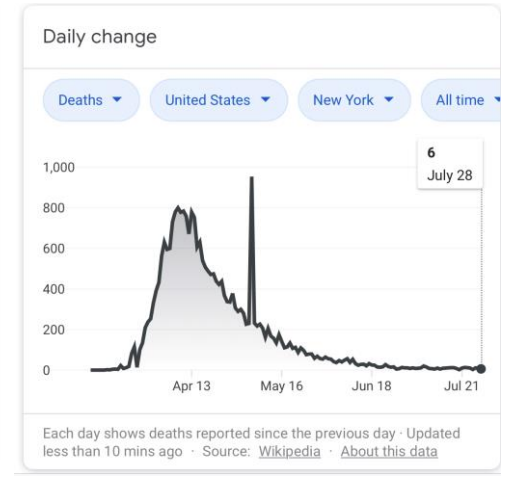
>6m tested (1/3 population)



>1m tested (<1/30 population)

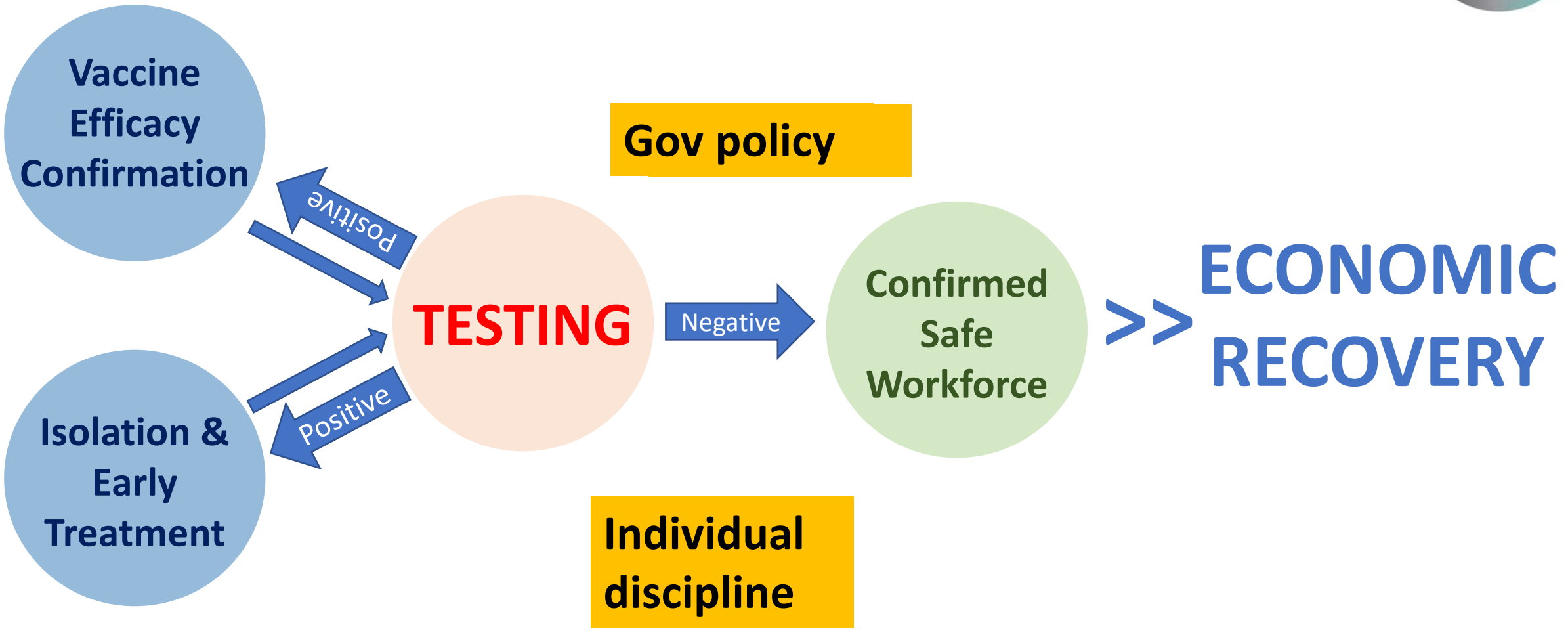






data from Source: Wikipedia Template: COVID-19 pandemic data

TESTING AND ECONOMIC RECOVERY



Dr HY Poon, PhD Cambridge, UK

- Project Director at JTTC
- Assisting Prof Tam with project developments and fund raising
- A pharmacologist and pharmacist by training
- Previous experience in clinical trial, diagnostics, botanical pharmaceutical and clean energy project developments

“TEST, TEST, TEST”

Continuum of Medical Care

Most Diseases: **Prevention-Diagnosis-Treatment**

Infectious Diseases: Prevention-Diagnosis-Treatment/**Prevention**

“TEST, TEST, TEST”

- **Testing** has been the WHO’s core strategy against the current COVID-19 pandemic.
- Current COVID-19 pandemic highlights the importance of diagnostic technologies in the fight against novel infectious diseases.
- Innovations in diagnostic technologies help quickly built the first line of defense in the fight against any outbreaks of infectious diseases, both known or unknown.

TESTING IS CRITICAL : AVAILABILITY

Timeline of COVID-19 test development

Jan 10	Coronavirus genome released by Chinese scientists online.
Jan 15	First known Covid-19 sufferer arrived on US soil.
Jan 16	Scientists in Germany announced the development of the first diagnostic test for COVID-19
Jan 27	First COVID-19 test approved in Korea
Jan 20	US CDC confirmed the first positive case of COVID-19 in the US.
Jan 24	CDC introduced to the world the new test kit for COVID-19.
Feb 06	WHO shipped out 250,000 diagnostic tests (partly based on the German design) to 70 labs around the world.
Feb 18	CDC warned laboratories across the country against the use of non-FDA approved testing kits.
Feb 28	CDC unveiled new Covid-19 test kit and streamlined commercial testing development
Feb 29	CDC announced the 1st death from COVID-19 in the US and barely 4,000 people had been tested nationwide.

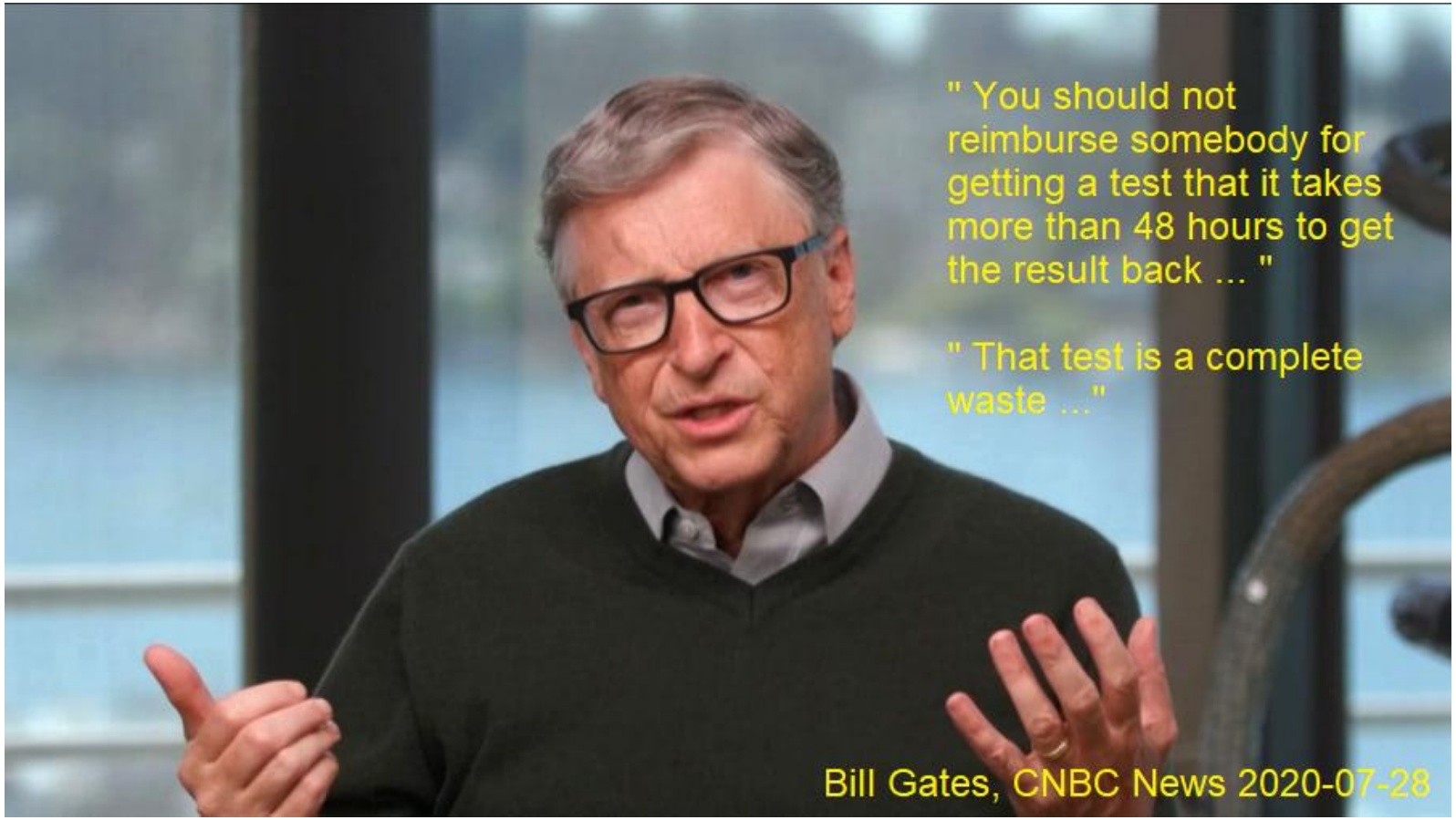
TESTING IS CRITICAL : AVAILABILITY

Outcome:

- Irreversible damage has been done to the effort to contain the spread of COVID-19 in the month when US CDC and FDA were struggling to come up with a functional test for COVID-19.
- As of July 30, 4,568,375 confirmed cases and 153,848 deaths have registered in the US.
- If the current trend remains unchecked, soon a 100,000 daily new cases have been projected.

https://www.worldometers.info/coronavirus

TESTING IS CRITICAL : SPEED



The turnaround time for Covid-19 tests can take several days to a week or longer for many patients in the US.

TESTING IS CRITICAL : SPEED

- Speed is most critical for effective contact tracing.
- A delay of 3 days or more between symptom onset and testing will not sufficiently reduce onward transmission of the virus.
- Long turnaround time means extended period of disease spread and delayed medical intervention

TESTING IS CRITICAL : SPEED

- **Pooled testing** increase COVID-19 screening without added resources.
- Samples from multiple individuals are tested together and a negative result would clear all pooled samples.
- If positive, each member of the pool is then tested individually.

TESTING & SEQUENCING

- By sequencing the virus from EVERY person infected in **Iceland**, researchers get to find out how the infection was caught, the way it spreads, and how it mutates as it spreads.
- This ‘molecular epidemiology’ can reveal the geographic origin of the virus in every single case.

TESTING & SEQUENCING

Insights into how COVID-19 spreads

- Parents commonly infected their children but rarely the other way round.
- Research done by HKU has also found that viral genetic sequences in some cases emerging in the current wave were different from those in the previous months, suggesting the current infections came from imported cases.

EMERGING COVID-19 DIAGNOSTICS

Artificial Intelligence

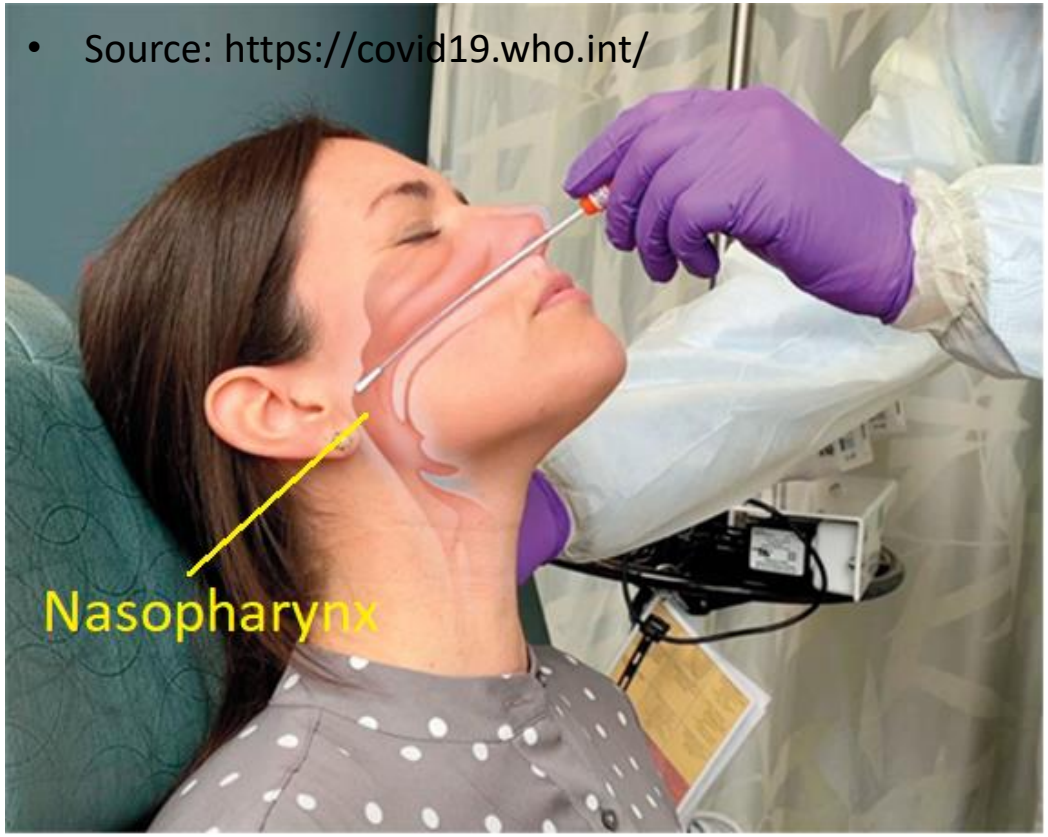
- AI-powered diagnosis system developed by **Alibaba** claims to detect new COVID-19 cases (up to 96% accurate) using computerized tomography scans to complete the recognition process within 20 seconds.

EMERGING COVID-19 DIAGNOSTICS

Big Data & AI

- **BlueDot** in Toronto uses a platform built around big data, AI and machine learning to track and predict the outbreak and spread of infectious diseases by gathering data globally 24/7. BlueDot had spotted what would come to be known as COVID-19, nine days before WHO released an official alert about the emergence of a novel coronavirus.

EMERGING COVID-19 DIAGNOSTICS



- Source: https://covid19.who.int/

Manual collection of nasopharyngeal specimens with the swab technique

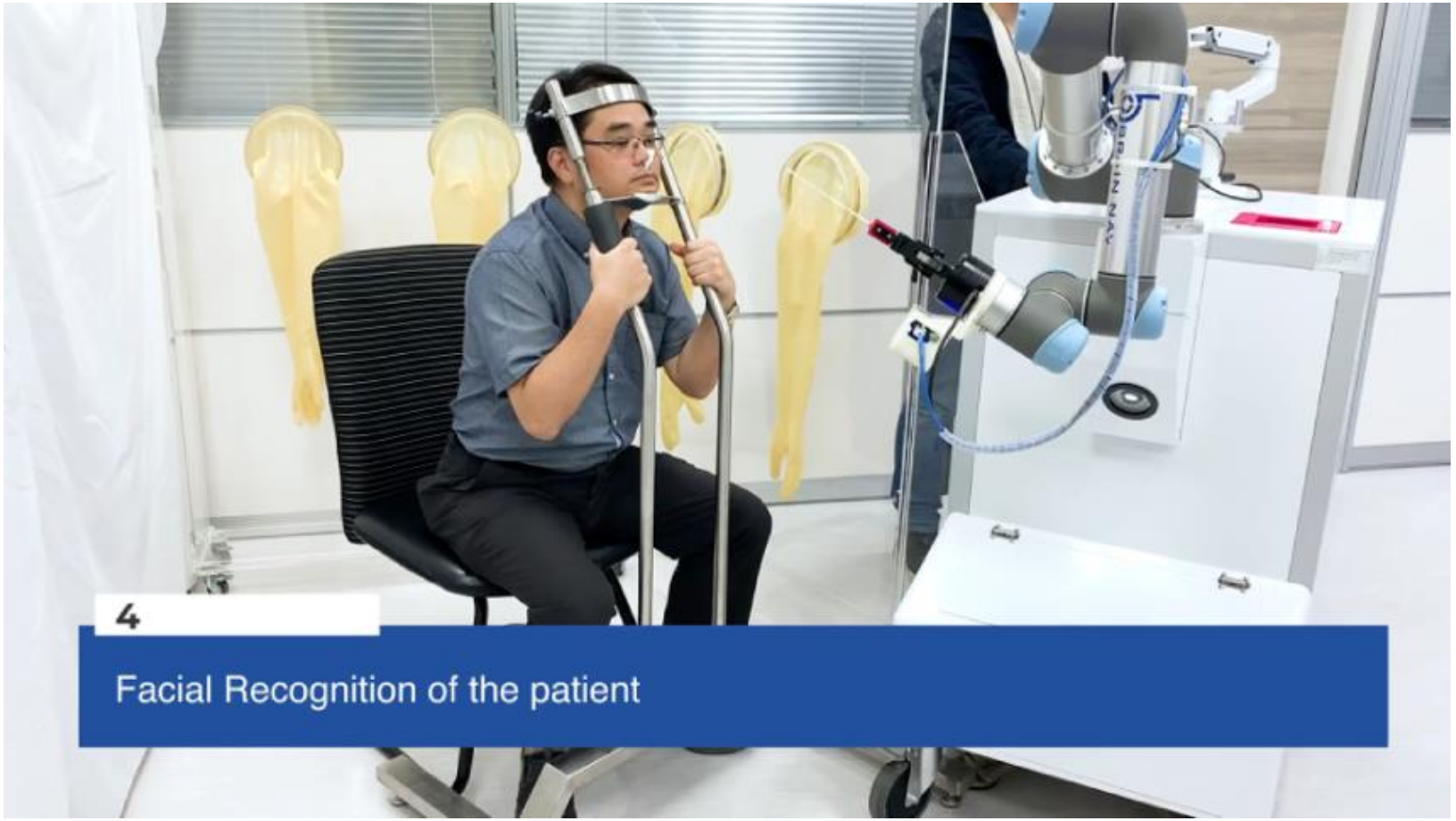
Source: https://brainnavi.com/nasalswabrobot/

EMERGING COVID-19 DIAGNOSTICS

Robotics (Brain Navi, Taiwan)

- Nasal swab is to insert into the nasopharyngeal cavity a swab and rotating it several times to collect sample for to test for coronavirus
- **Automatic** sample collection by robots minimizes the risk of exposing healthcare providers to infection
- The robot uses **facial recognition** to determine precise nostril position before swab insertion

EMERGING COVID-19 DIAGNOSTICS

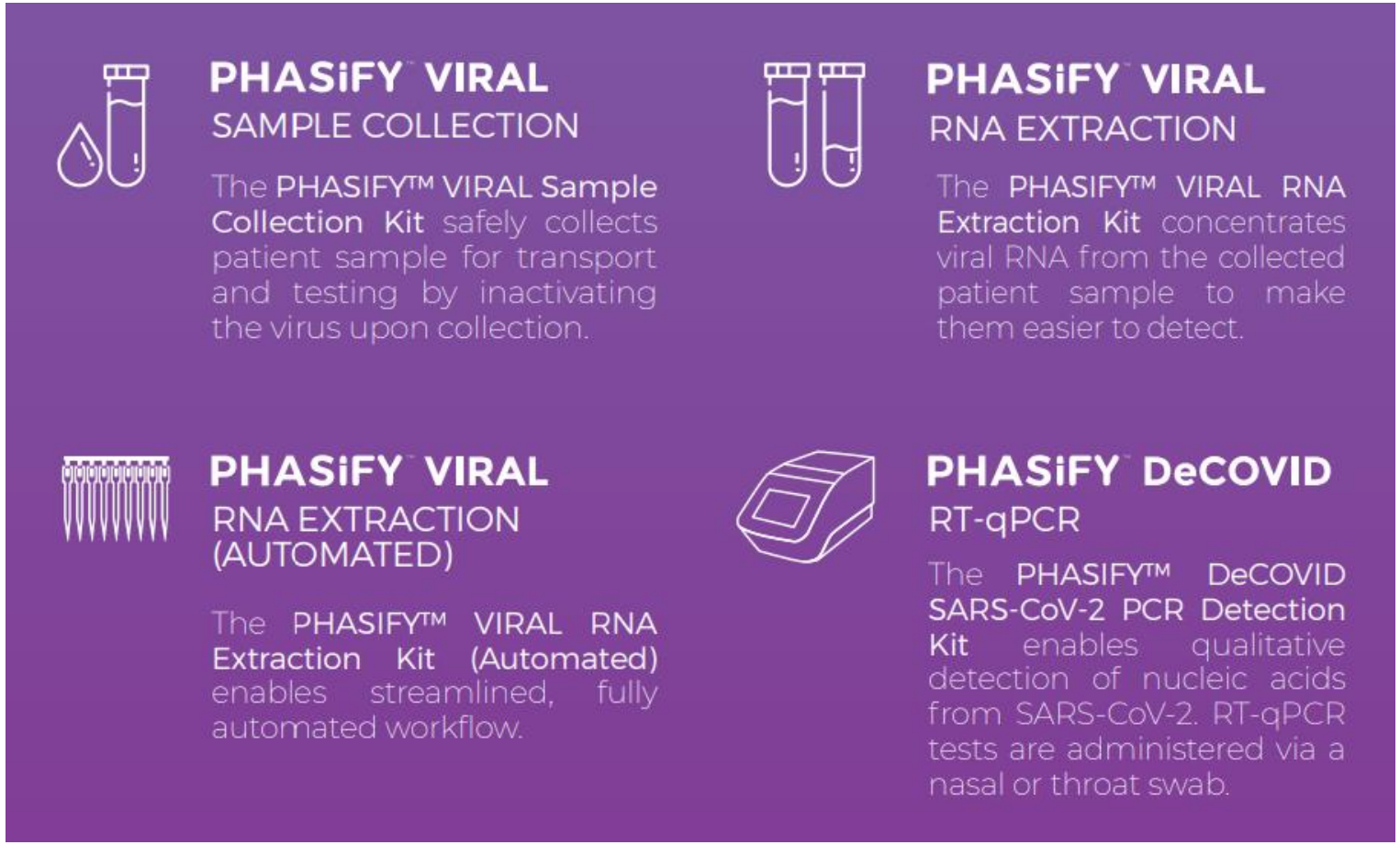


EMERGING COVID-19 DIAGNOSTICS

Mircofluidics & Lab-On-Chip

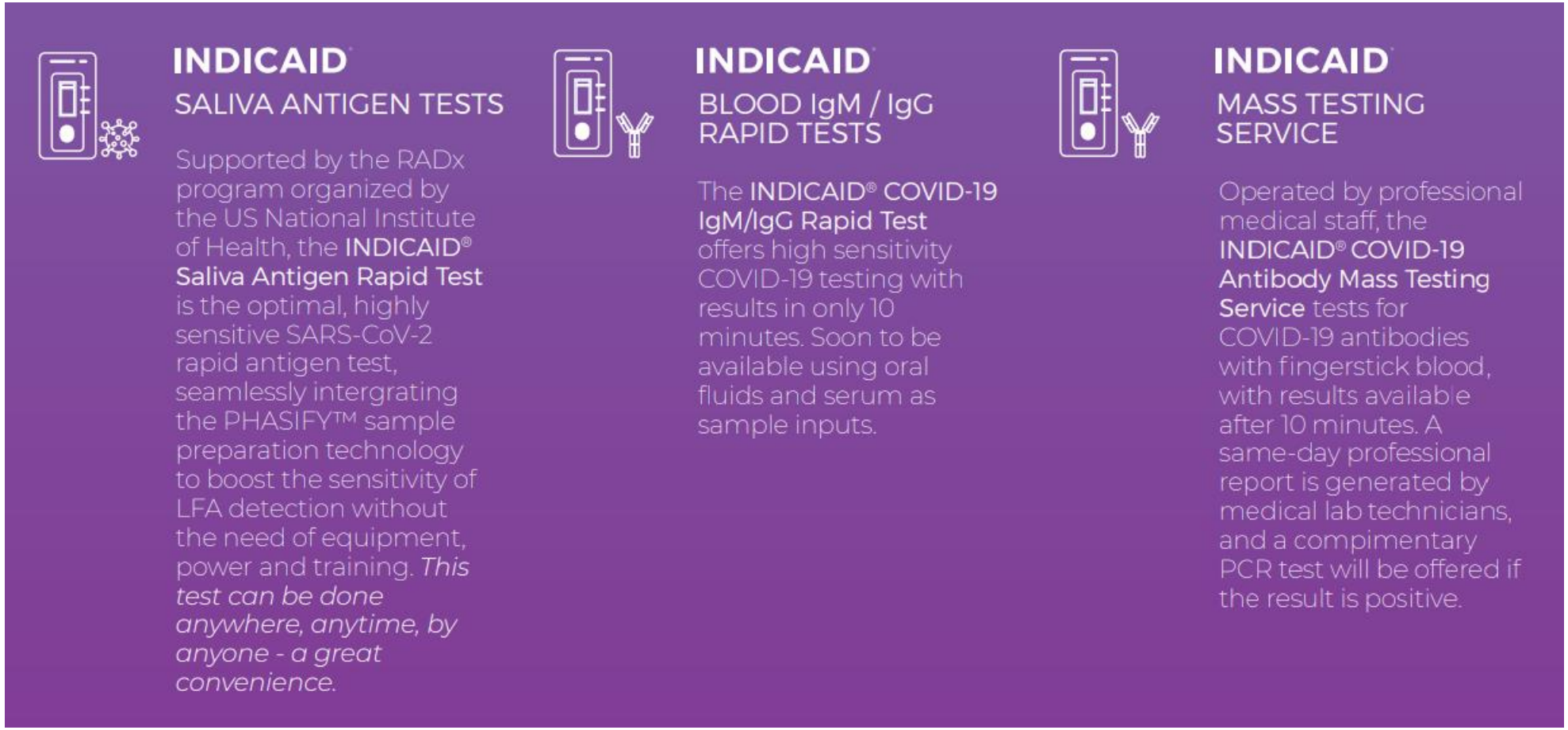
- **Sanwa Biotech's** microfluidic, disposable **Lab-On-Chip (LOC) platform** comprises of an array-based LED-induced fluorescence immunoassay device, a single-use biochip, and the biomarker array for the diseases being diagnosed.
- The system, **fully automated** and **portable,** is able to diagnose a range of respiratory diseases, including COVID-19 antigen, within **15 minutes**, and with an accuracy of between **90 to 100 %.**

EMERGING COVID-19 DIAGNOSTICS



Source: Phase Scientific International (PSI)

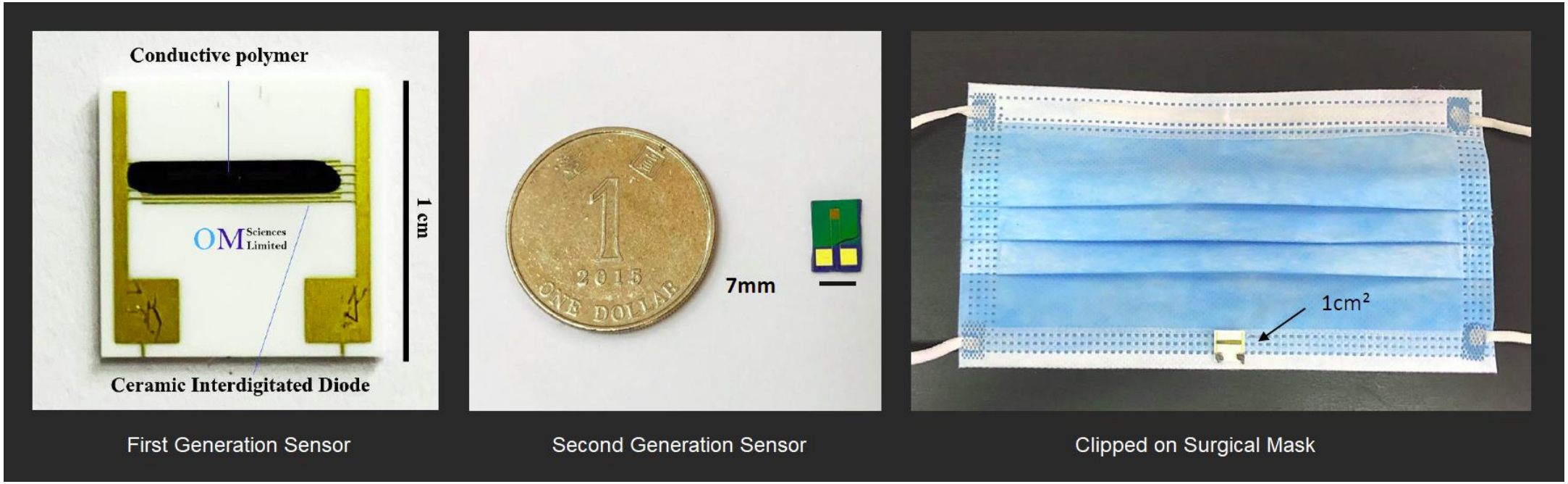
EMERGING COVID-19 DIAGNOSTICS



Source: Phase Scientific International (PSI)

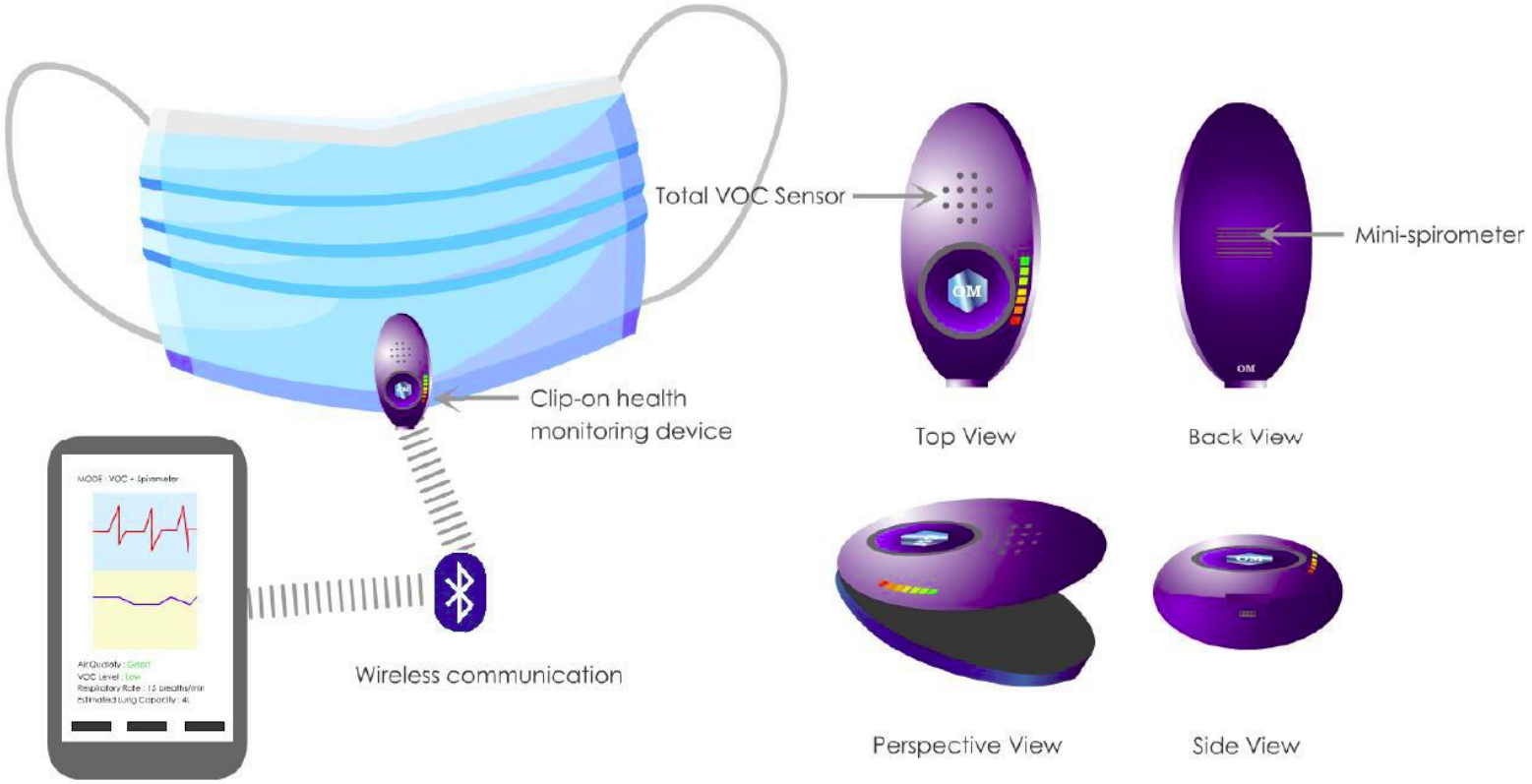
EMERGING COVID-19 DIAGNOSTICS

OM SCIENCES – PORTABLE SPIROMETER ON MASK



Source: OM Science

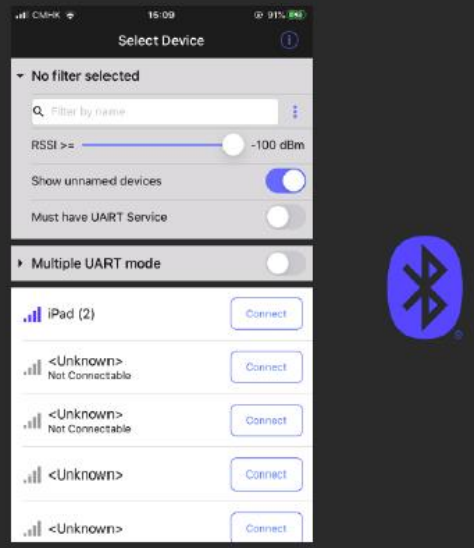
EMERGING COVID-19 DIAGNOSTICS



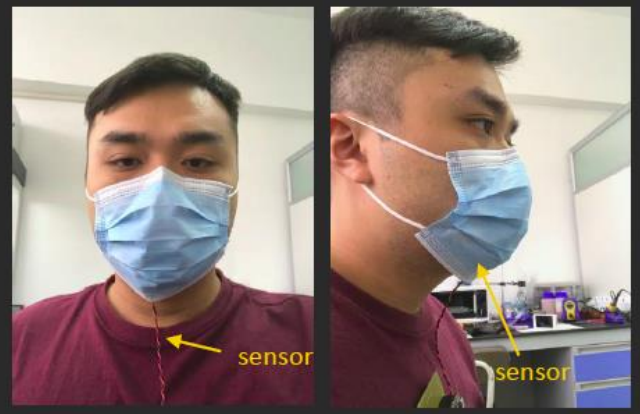
Concept art of OM Spirometer or VOC sensor

Source: from OM Science

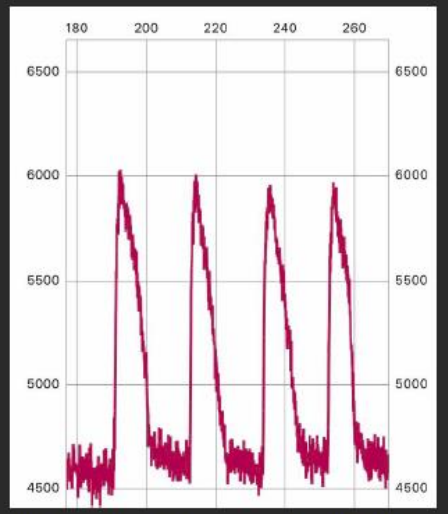
EMERGING COVID-19 DIAGNOSTICS



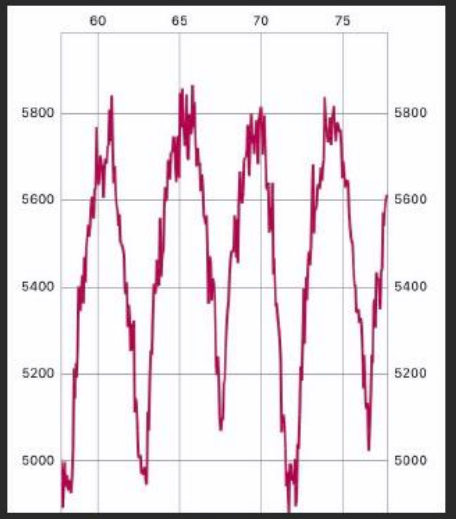
1. Connect the sensor **with** the app using Bluetooth



2. Put the sensor under the mask then breath normally



Forced vital capacity (FVC)



Normal breathing

3. Exhale and inhale data will be transferred to smartphone

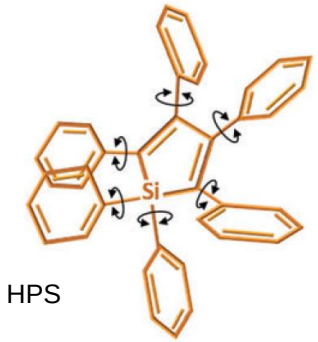
Source: from OM Science

Aggregation-Induced Emission

AUISET™ Biotechnology Co Ltd 欧艾赛特生物科技有限公司

The Hong Kong University of Science and Technology

Aggregation-Induced Emission (AIE) Molecules – A New Generation of Fluorescent Probe



HPS

Non-Emissive in Solution under Light Irradiation
Emission is quenched by intramolecular rotation

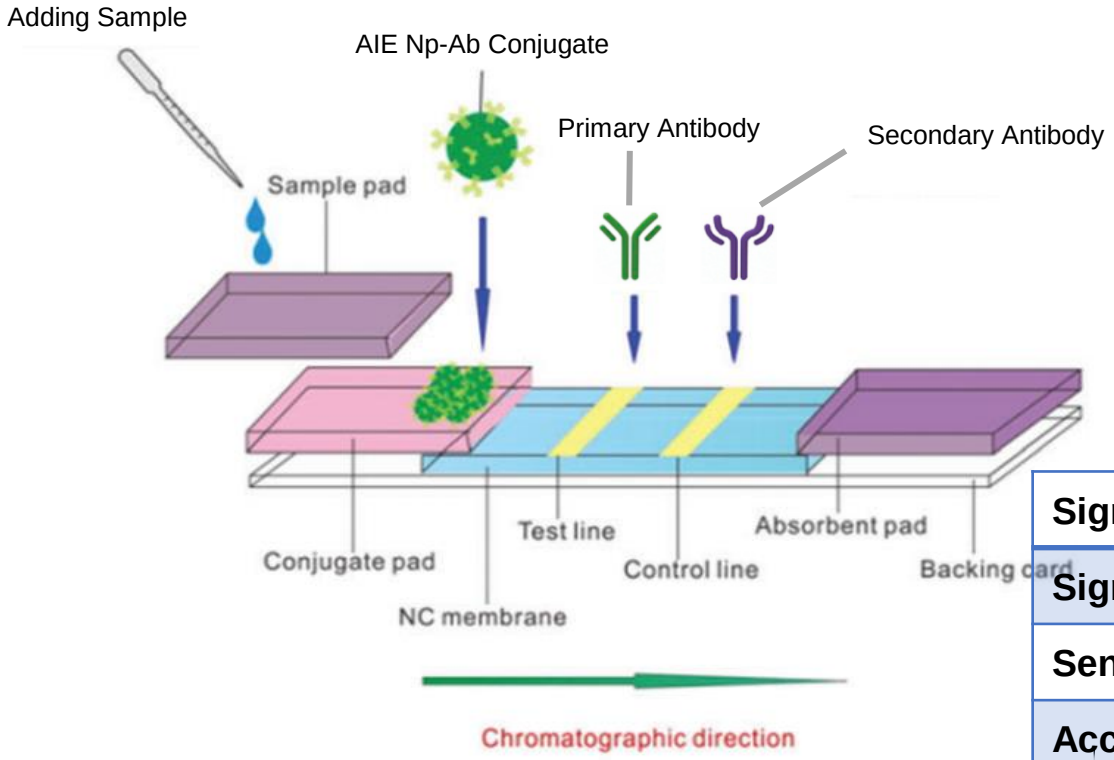
AIE molecules in good solvents

Highly Emissive in Aggregates under Light Irradiation
Restriction of intramolecular rotation

AIE molecules in poor solvents or solid state or polymer matrix

	FITC (traditional fluorophores)	AIE fluorophores
Photostability	Susceptible	**Resistant**
Luminescence Quantum Yield	Low	**High**
Quenching in High Concentration	Yes	**No**
Background Signal	High due to small stokes shift	**Low** due to large Stokes shift
Nanoparticle Form	Inferior due to concentration quenching	**Perfect**

Lateral Flow Immunoassay for nCovid-19 Detection



Colloidal Gold Antibody Conjugates

AIE Nanoparticle Antibody Conjugates

Signal Label for LFA	Colloidal Gold	AIE-Np
Signal Output	Colour	Luminescence
Sensitivity	Low	Very High
Accuracy	Low	High
Detection Range	Narrow	Wide
Read-out Mode	+ / --	Digital

IP RIGHTS VS NATIONAL EMERGENCY

- Private Property Right vs Public Good
- **Compulsory licensing** (TRIPS, WTO) offers governments to get round patent protection to ensure that generic versions of patented **innovations** be made available at **affordable** prices.
- **AbbVie** has relinquished global patent rights of potential COVID-19 treatment of **Kaletra**. **Gilead Sciences** has a similar arrangement for its **remdesivir**.
- Royalty rates set variably at certain % of generic prices by governments, e.g. 0 – 6% Japan, 0 – 4% Canada.

TESTING AND ECONOMIC RECOVERY

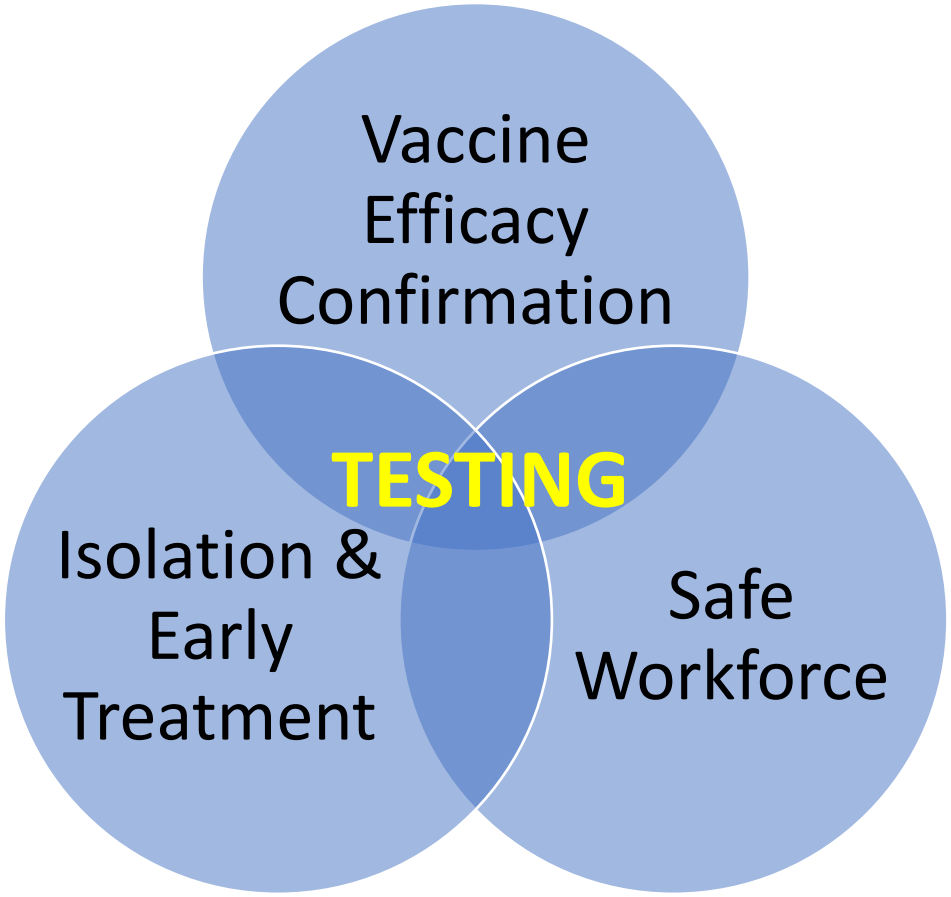
- Diagnostic testing may offer the faltering economies a lifeline – **Immunity** Passport
- Conduct blood testing to identify people who have recovered from COVID-19 and may have COVID-19 antibodies in the body to build up a “safe” workforce.

TESTING AND ECONOMIC RECOVERY

Hurdles to overcome:

- There is currently no conclusive scientific evidence supporting the notion that patients recovered from COVID-19 have sufficient antibodies to be immune from a re-infection as in the case of lifelong immunity in people recovered from chicken pox or polio.
- Ethical issues – Immunity passport system may establish a new divide in society, i.e. the immuno-privileged and the immuno-deprived and lead to even more socio-economic issues.

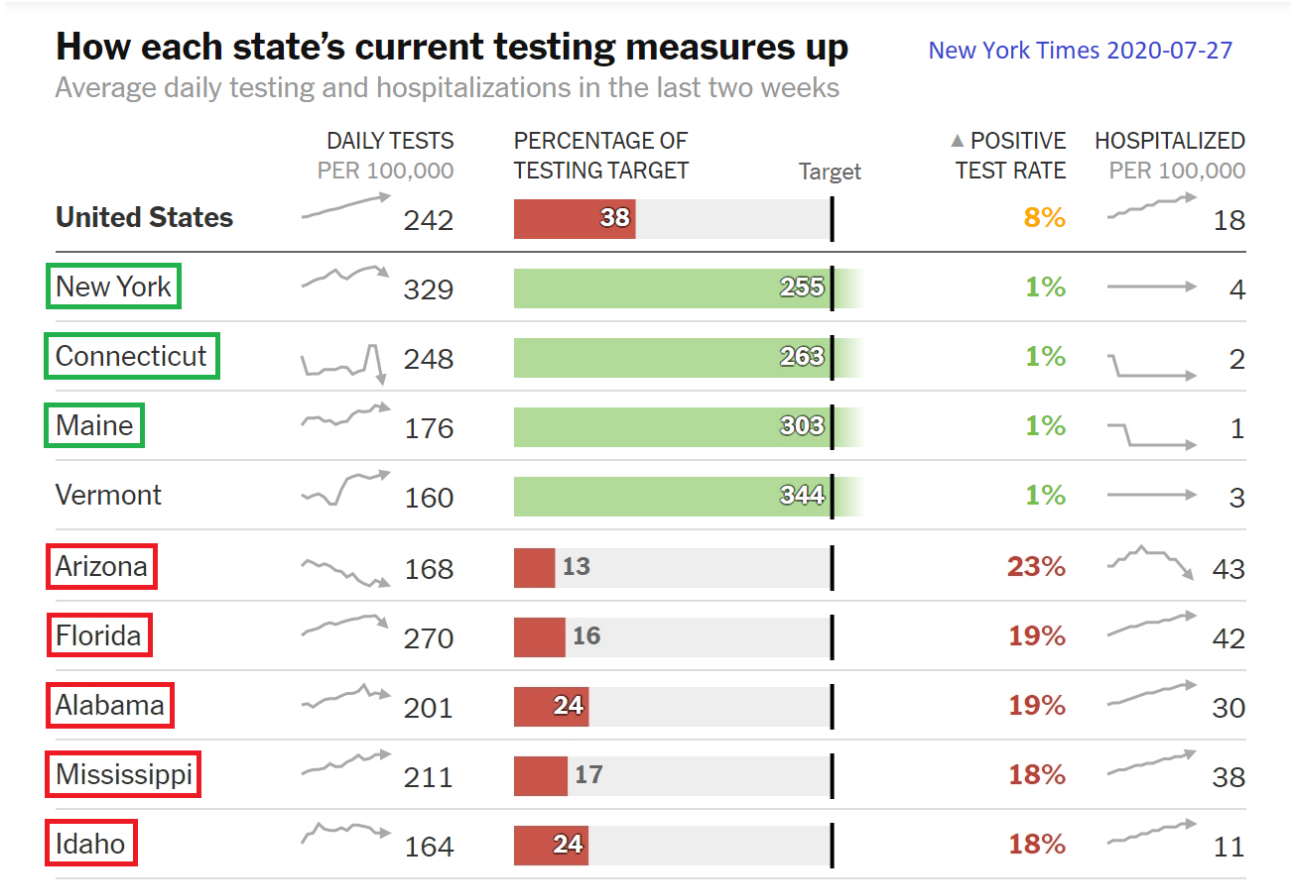
TESTING AND ECONOMIC RECOVERY



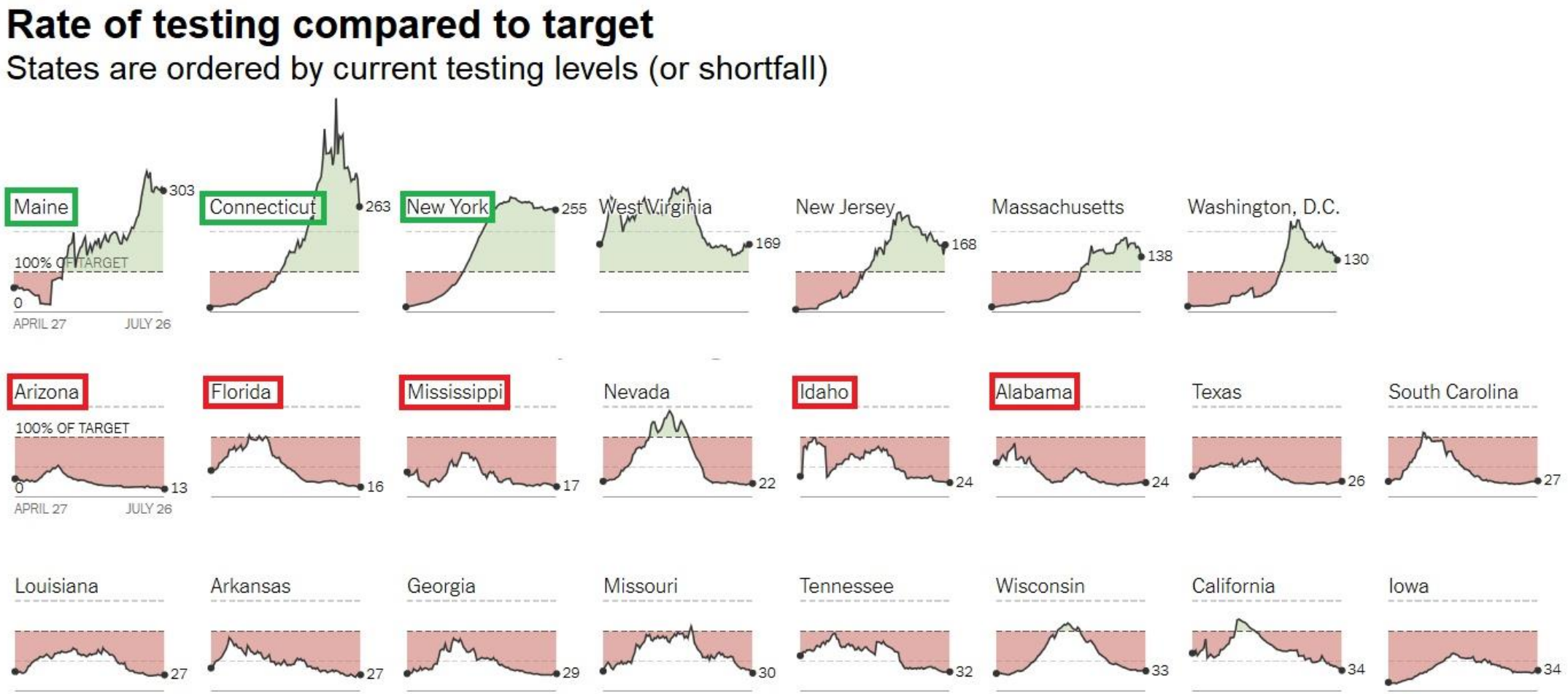
>> **ECONOMIC RECOVERY**

Thank You

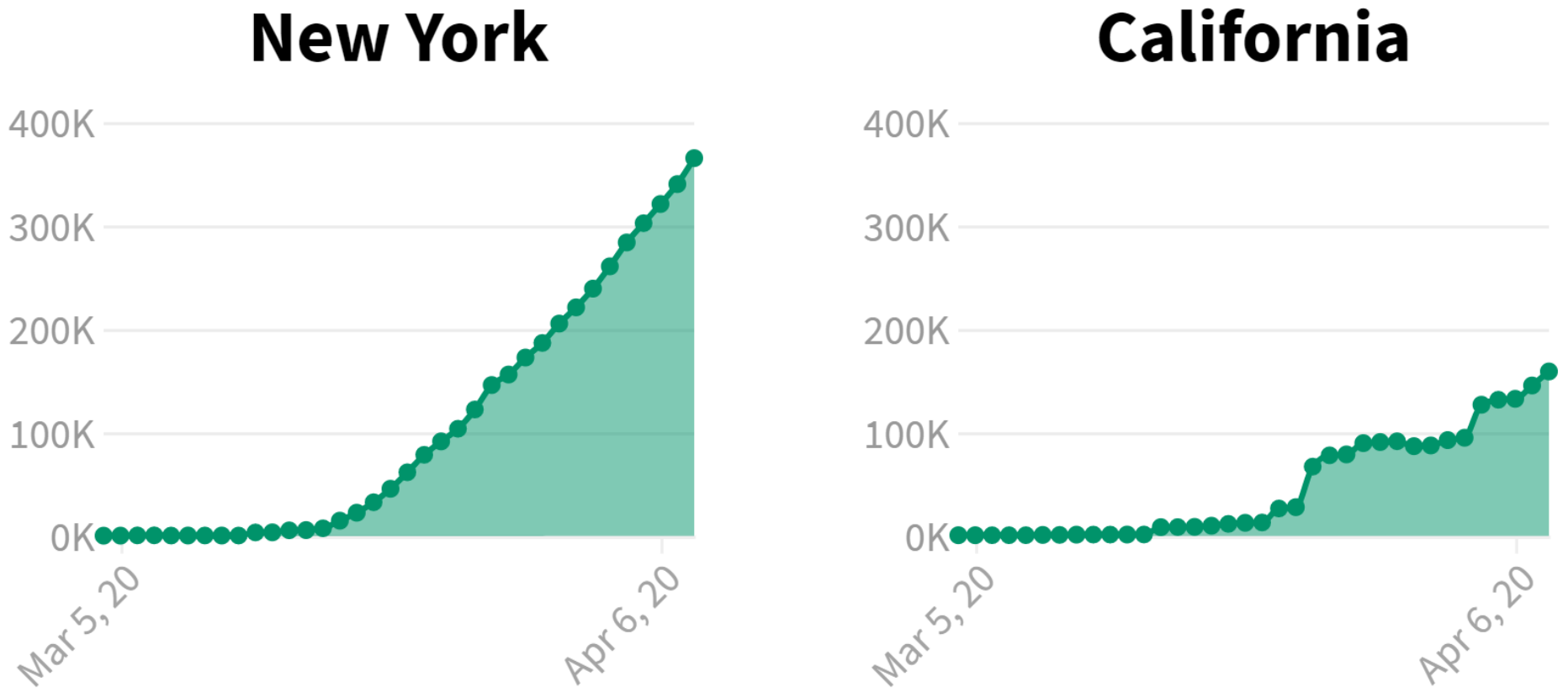
POSITIVE TEST RATES OF US STATES



POSITIVITY & TESTING LEVEL

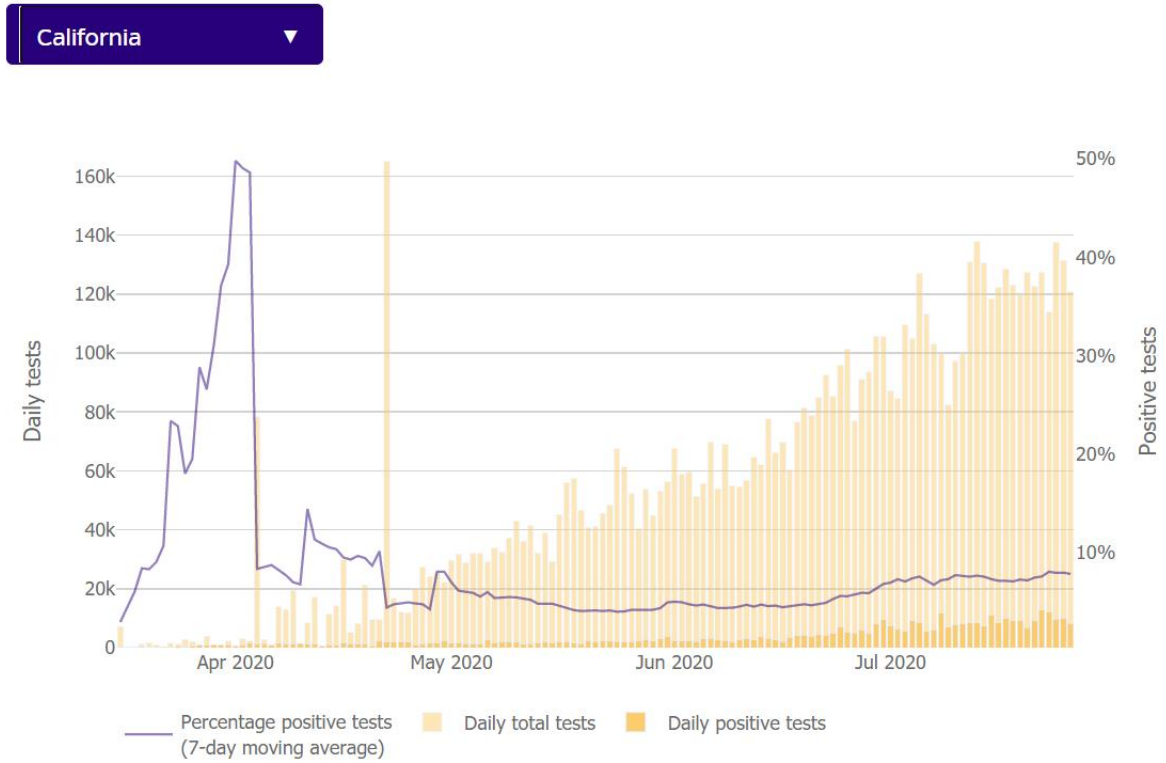


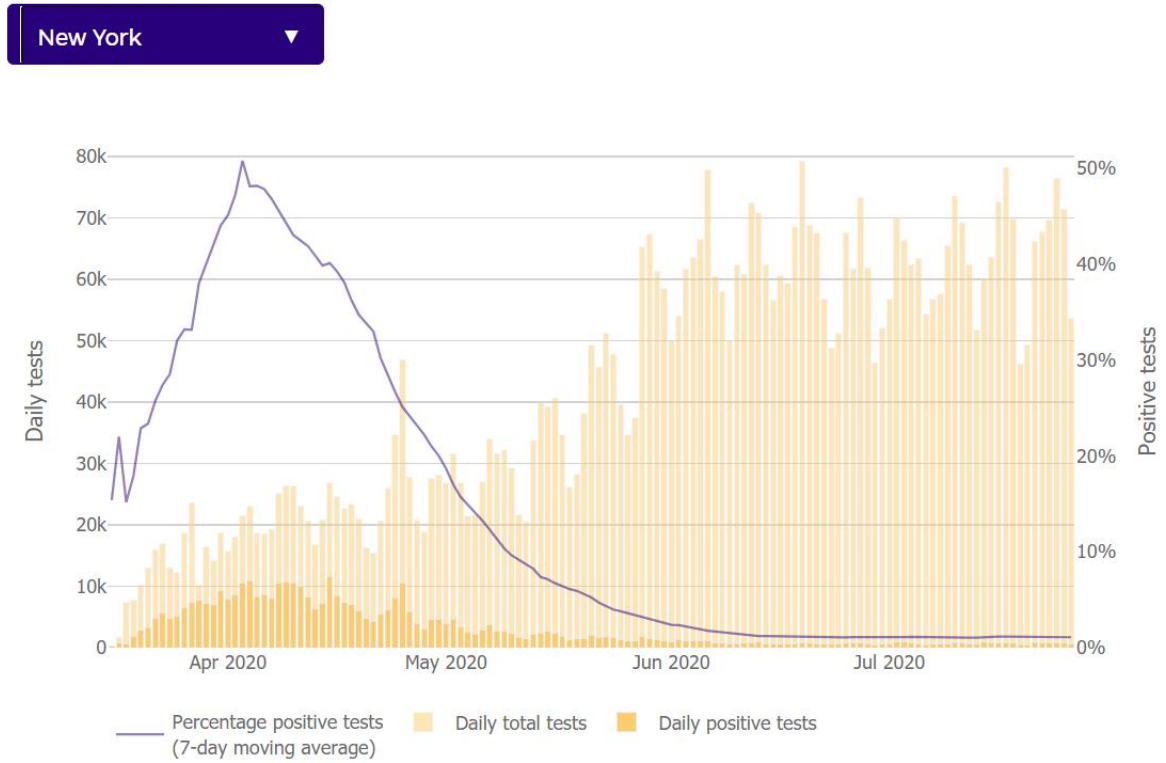
CALIFORNIA VS NEW YORK – TESTING



https://www.businessinsider.com/state-coronavirus-testing-compared-timeline-2020-4

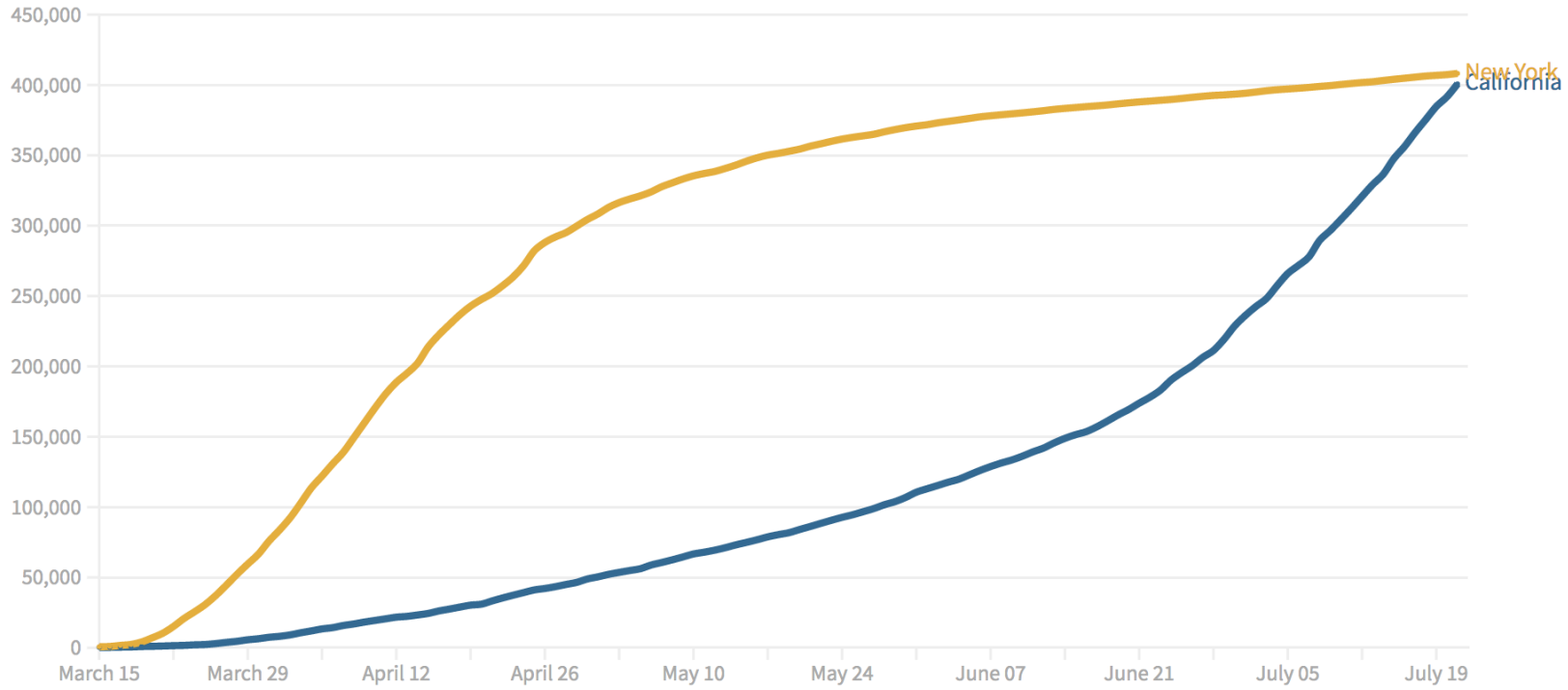
CALIFORNIA VS NEW YORK – POSITIVITY





CALIFORNIA VS NEW YORK – CASES

Cumulative COVID-19 Cases for California vs New York
California is about to surpass New York in total cases.

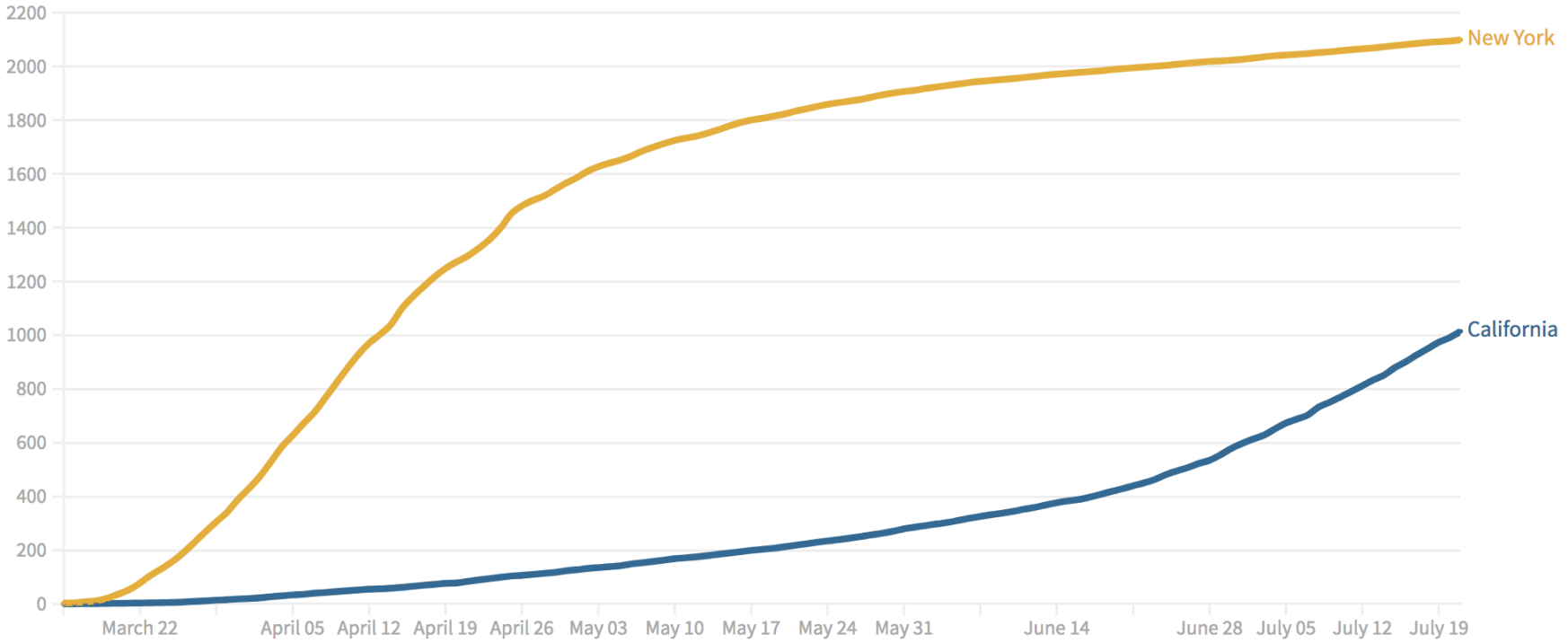


Source: COVID Tracking Project

CALIFORNIA VS NEW YORK – TESTS

Per Capita Cumulative COVID-19 Cases for California vs New York

New York's rate is currently double that of California, even with cases rapidly rising.



Source: COVID Tracking Project • Per capita is calculated per 100,000 people.