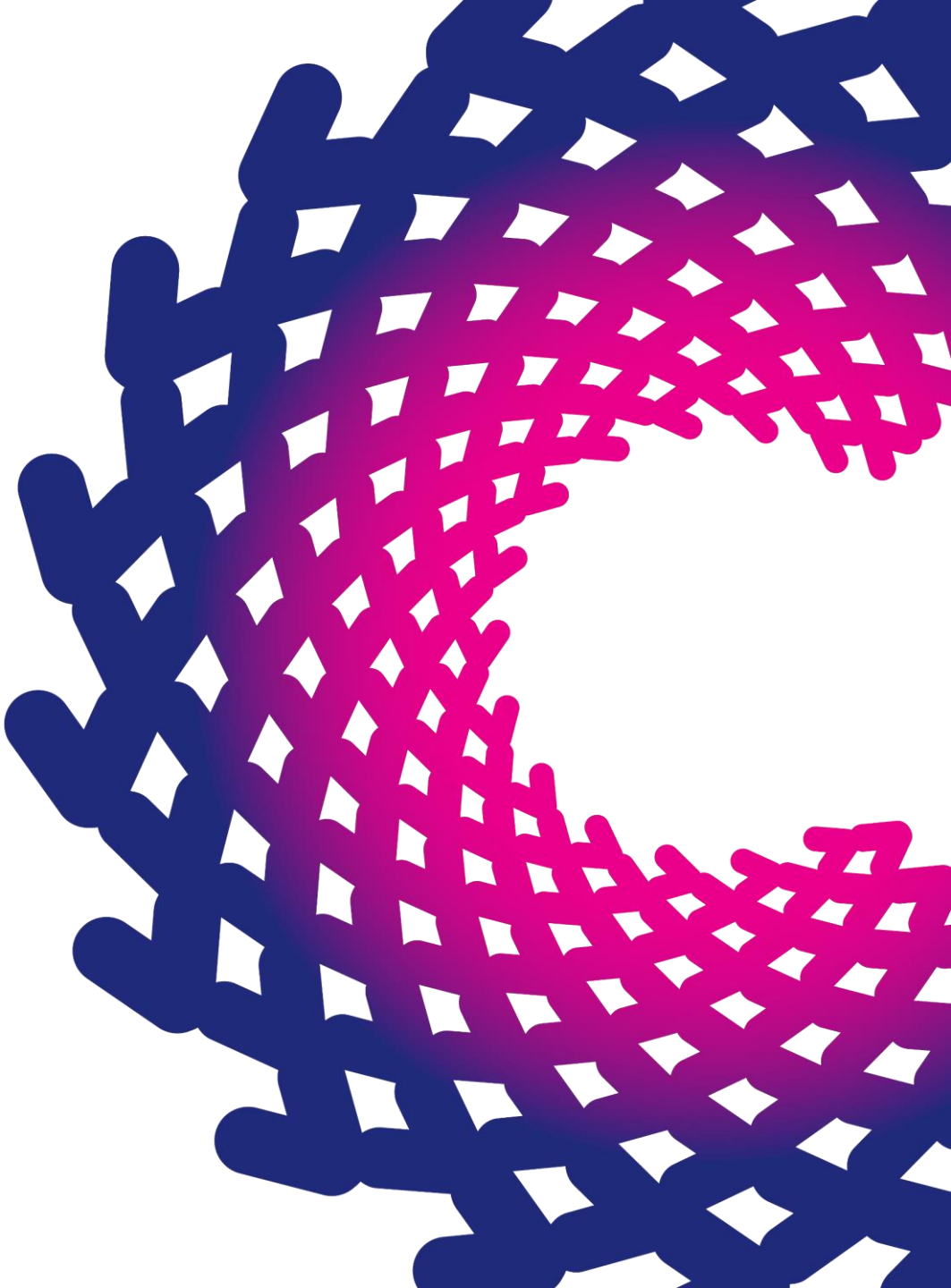
COLORADO BIOSCIENCE ASSOCIATION

Bio Biotechnology Innovation Organization

DEVELOPING AND DISTRIBUTING A COVID-19 VACCINE:

A BRIEFING FROM NATIONAL EXPERTS



OCTOBER 26, 2020

SPEAKERS

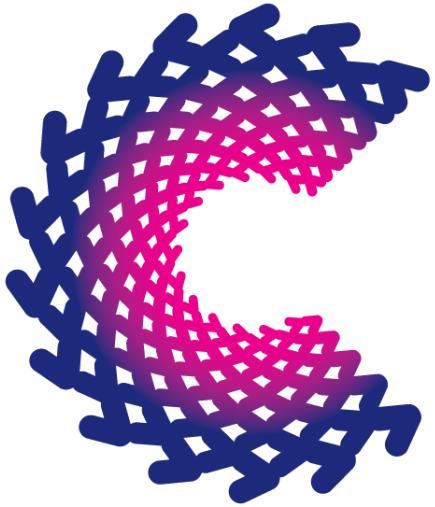
Michael Mullette
Vice President
North America Commercial Operations
Moderna

Phyllis Arthur
Vice President
Infectious Diseases & Diagnostics Policy
BIO

Andrew Powaleny
Director
Public Affairs
PhRMA

Bio Biotechnology Innovation Organization

COLORADO BIOSCIENCE ASSOCIATION



COLORADO BIOSCIENCE ASSOCIATION

CBSA creates co-opportunity for the Colorado life sciences community.

COLORADO BIOSCIENCE ASSOCIATION

720 LIFE SCIENCES COMPANIES AND ORGANIZATIONS

- BIOTECHNOLOGY
- PHARMACEUTICALS
- DIAGNOSTICS
- MEDICAL DEVICES
- DIGITAL HEALTH
- AG BIO + ANIMAL HEALTH
- ACADEMIC + RESEARCH INSTITUTIONS

LOGISTICS

All participant microphones are muted.

Ask questions! Enter your questions in the Q&A function.

COLORADO BIOSCIENCE ASSOCIATION

COVID-19 VACCINE (mRNA-1273)

MICHAEL MULLETTE

VICE PRESIDENT, NORTH AMERICA COMMERCIAL OPERATIONS

moderna

MODERNA DEVELOPMENT PIPELINE

SEPTEMBER 2020

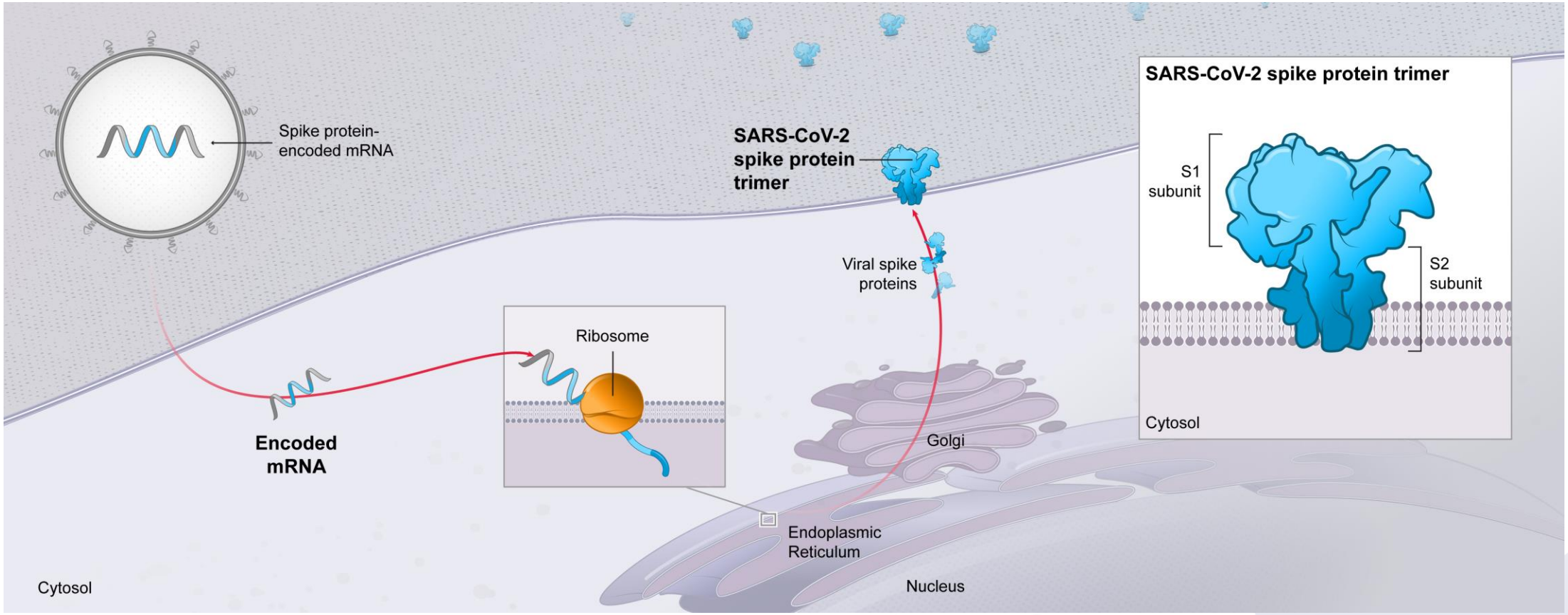
moderna

COLORADO BIOSCIENCE ASSOCIATION

		Preclinical *(incl. Open IND)*	Phase 1	Phase 2	Phase 3	Commercial
Core modalities	Prophylactic vaccines	EBV; *Pediatric RSV (Open IND)*	Flu (Pandemic); Adult RSV *(mRNA1172)*; Zika; Adult RSV *(mRNA1777)*; hMPV/PIV3	*Phase 2 preparations Zika*; CMV	COVID-19; *Phase 3 preparations CMV*	*Launch preparation COVID-19*
	Systemic secreted & cell surface therapeutics	Relaxin; PD-L1; IL-2	Chikungunya antibody			
Exploratory modalities	Cancer vaccines		KRAS	Personalized Cancer Vax		
	Intratumoral immuno-oncology		IL-12; OX40L/IL-23/IL-36γ	OX40L		
	Localized regenerative therapeutics			VEGF		
	Systemic intracellular therapeutics	MMA; PA *(open IND)*; PKU; GSD1a				

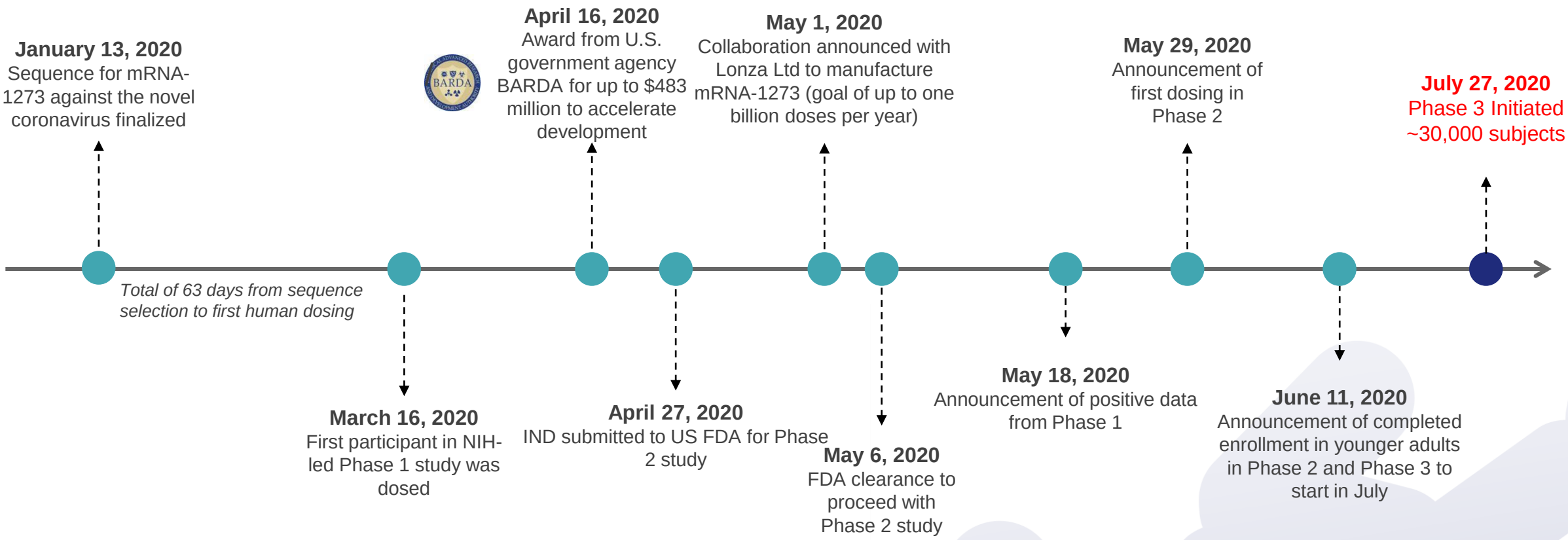
SARS-COV-2 VACCINE (mRNA-1273)

ENCODES FOR THE FULL SPIKE S PROTEIN



mRNA-1273 PROGRAM TIMELINE

mRNA-1273 timeline: Research and development of SARS-CoV-2 vaccine



COVE D&I ADVISORY COMMITTEE

Remit and Role of Advisory Committee:

1. Review enrollment, race, and ethnicity demographics on a weekly basis
2. Review current outreach activities and outcomes
3. Review strategies to ensure participation of individuals from communities significantly impacted by COVID-19
4. Support the development and implementation of retention strategies

MODERNA

NATIONAL INSITITUTES OF HEALTH

- National Institute on Allergy and Infectious Diseases
- National Institute on Minority Health and Health Disparities
- NIH, Tribal Health Research Office
- NHLBI

OPERATION WARP SPEED

COVPN

US DEPARTMENT OF VETERAN AFFAIRS

FAITH COMMUNITY

PHASE 3 COVE STUDY HAS ENROLLED ALL 30,000 PARTICIPANTS

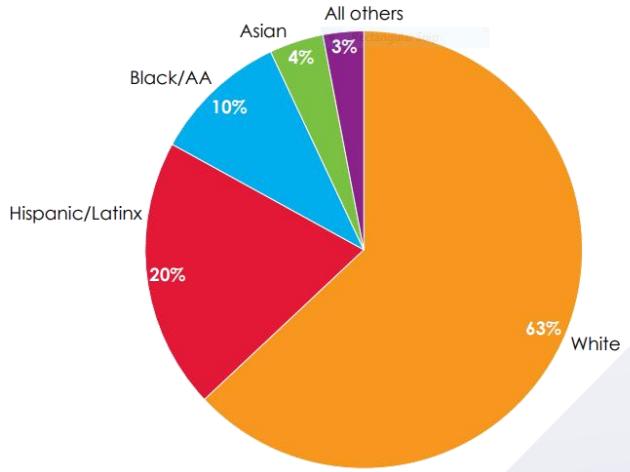
Phase 3 Enrollment Status

A vaccine for everyone…find yourself in the Cove study

Phase 3 Diversity Status

Race and ethnicity

Interim data snapshot - October 21, 2020 - subject to change



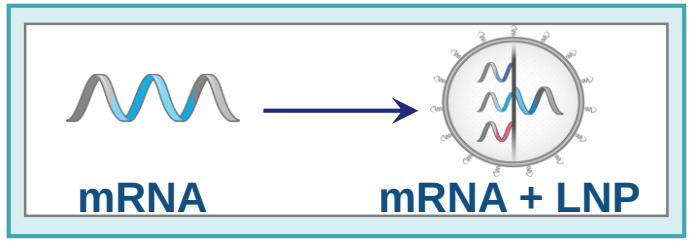
MODERNA MANUFACTURING COLLABORATIONS

moderna COLORADO BIOSCIENCE ASSOCIATION

United States

moderna + Lonza (US)

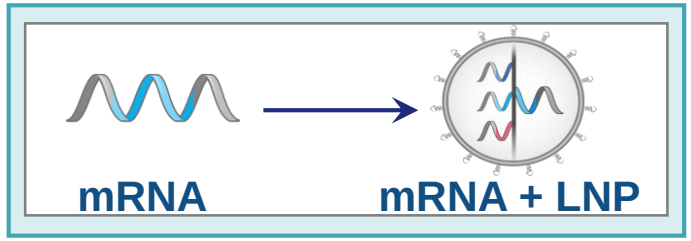
Pharma & Biotech



Catalent

Independent supply chains

Manufacturing scale up to supply 500 million to 1 billion doses per year



International

Lonza (Switzerland)

Pharma & Biotech

ROVI

ROVI (Spain)

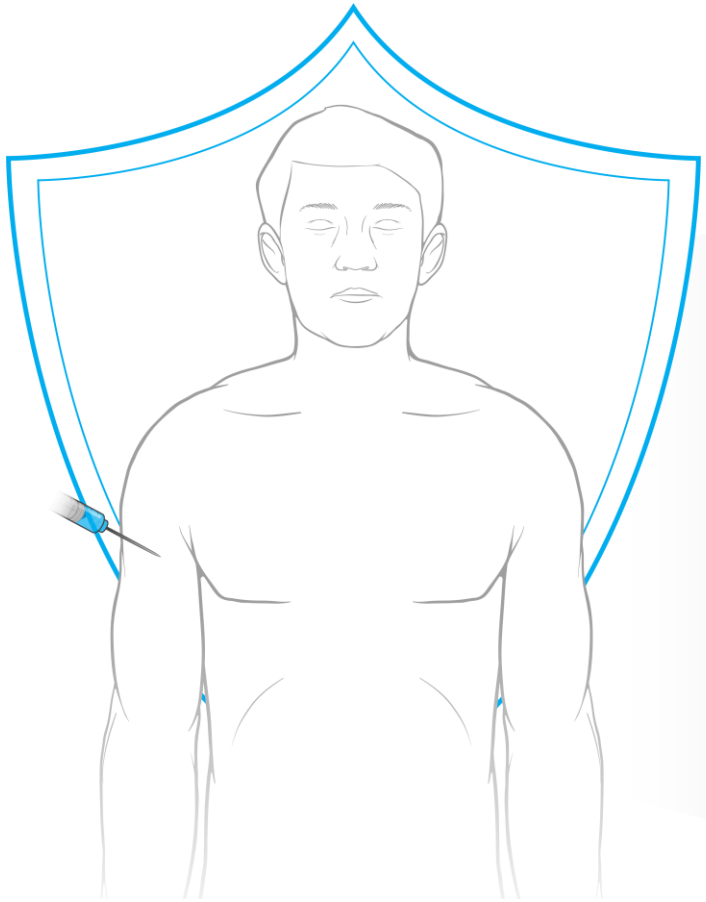
STANDARD 0.5 ML LIQUID ADMINISTRATION PROVIDED IN MULTI-DOSE VIALS

Standard needles & syringes

No dilution required

10 dose vials

Ready to use, draw 0.5mL and inject



Can be deployed in any setting:

Hospitals

Doctors' offices

Nursing homes

Immunization centers

CONTINUING OUR SUPPORT AROUND THE WORLD

moderna

COLORADO BIOSCIENCE ASSOCIATION

- *Clinical trials to ensure safe and effective vaccine*
- *Manufacturing at scale in US and around the world*
- *Building training, medical communication, education support*
- *Submitting regulatory dossiers in close collaboration with authorities*

COLORADO BIOSCIENCE ASSOCIATION

DEVELOPMENT AND IMPLEMENTATION OF COVID-19 VACCINES

PHYLLIS ARTHUR

VP, INFECTIOUS DISEASES AND DIAGNOSTICS POLICY

Bio Biotechnology Industry Organization

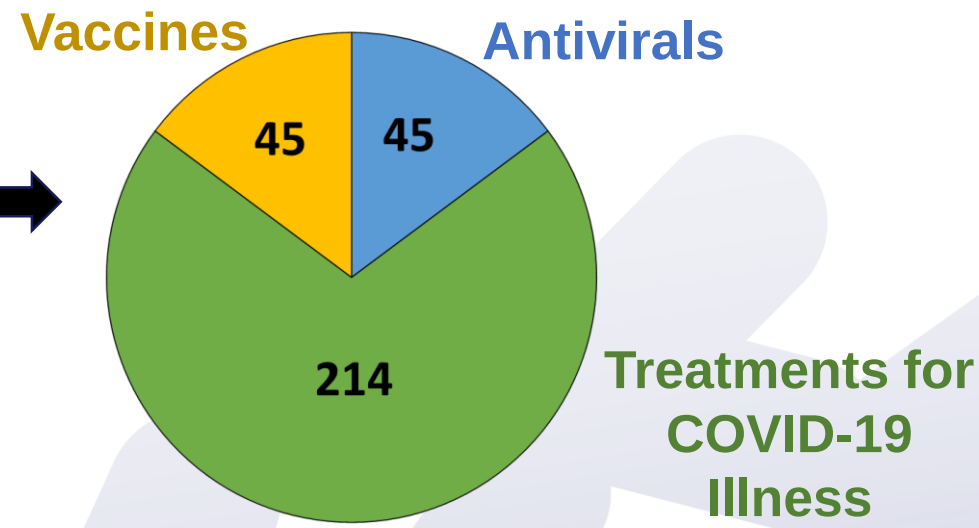
COVID-19 PIPELINE UPDATE (as of 10/19/2020)

Of 799 initiated drug programs, 759 remain active:

	Drug	Active	Inactive	Failed	Authorized
27%	Antivirals	204	12	5	3
48%	Treatments	363	8	4	6
25%	Vaccine	192	0	0	2
	Total	759	20	9	11

Preclinical 455 (60%)

Clinical 304 (40%)



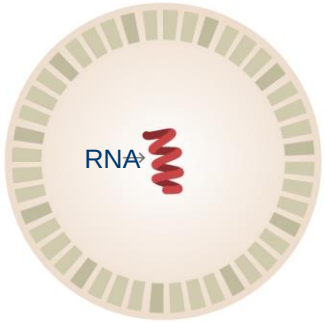
Biomedtracker, Biocentury, BIO Industry Analysis

TYPES OF VACCINES FOR SARS-COV2

Recombinant Protein Vaccine

Yeast or other cells can be engineered to carry a virus's gene and spew out viral proteins, which are then harvested and put into a vaccine. A coronavirus vaccine of this design would contain whole spike proteins or small pieces of the protein.

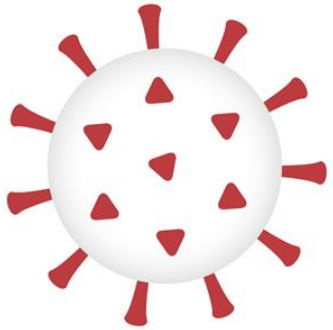
Genetic Vaccine (DNA or RNA)



DNA Vaccines: A circle of engineered DNA is delivered into cells. The cells read the viral gene, make a copy in a molecule called messenger RNA, and then use the mRNA to assemble viral proteins. The immune system detects the proteins and mounts defenses.

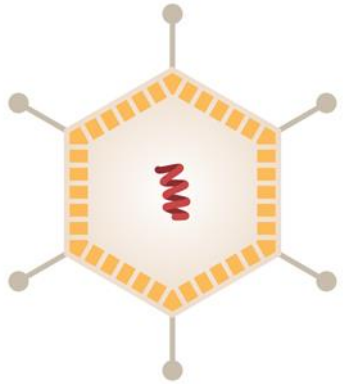
RNA Vaccines: Delivers messenger RNA into cells. The cells read the mRNA and make spike proteins that provoke an immune response.

Virus-like or Nanoparticle Vaccine



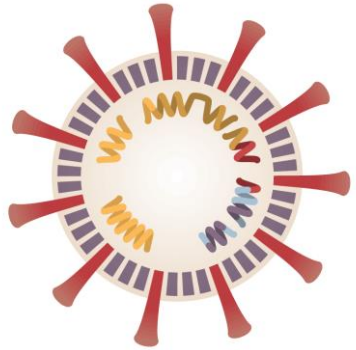
These vaccines are particles that contain pieces of viral proteins. They can't cause disease because they are not actual viruses, but they can still show the immune system what coronavirus proteins look like.

Viral Vector Vaccine



To create a coronavirus vaccine, several teams have added the spike protein gene to a virus called an adenovirus. The adenovirus slips into cells and unloads the gene. Because the adenovirus is missing one of its own genes, it cannot replicate and is therefore safe.

Whole-Virus Vaccine



Incorporates an inactivated or weakened form of a virus that is not able to cause disease. When immune cells encounter them, they make antibodies.

Source: https://www.nytimes.com/interactive/2020/05/20/science/coronavirus-vaccine-development.html

Biomedtracker, Biocentury, BIO Industry Analysis

CLINICAL & PRECLINICAL STAGE VACCINE PIPELINE

Biotechnology Innovation Organization

COLORADO BIOSCIENCE ASSOCIATION

BARDA / DoD funding

OWS funded

Jointly developed

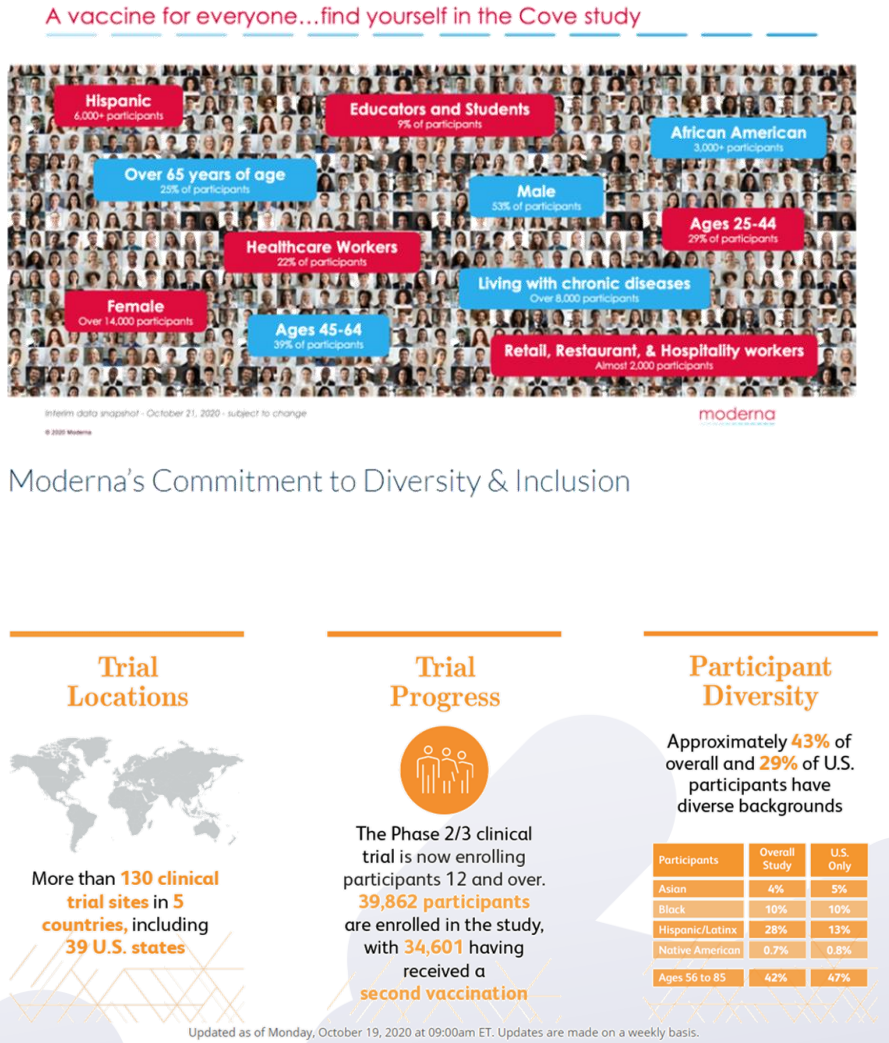
	Preclinical	Phase 1	Phase 2	Phase 3
Viral Vector		MERCK, THEMIS, 深圳市免疫基因治疗研究院 SHENZHEN GENO-IMMUNE MEDICAL INSTITUTE		Johnson & Johnson; 康希诺生物 CanSinoBIO; Gamaleya Research Institute; AstraZeneca, UNIVERSITY OF OXFORD
Viral Inactivated		MERCK, IAVI International AIDS Vaccine Initiative		国药山西 SINOPHARM; sinovac®
RNA[1]	SANOFI, TranslateBIO	PrEPBiopharm		BIONTECH, Pfizer; moderna™ (support from NIH, CEPI)
DNA			INOVIO POWERING DNA MEDICINES, Beijing Advaccine Biotechnology	
Cell Based	ARCHIVEL farma, Baylor College of Medicine, symvivo			
Recombinant protein		medicago, gsk; SANOFI, gsk		NOVAVAX Creating Tomorrow's Vaccines Today (support from CEPI)

Source: Biomedtracker, Biocentury, BIO Industry Analysis

Info as of Oct 25, not exhaustive

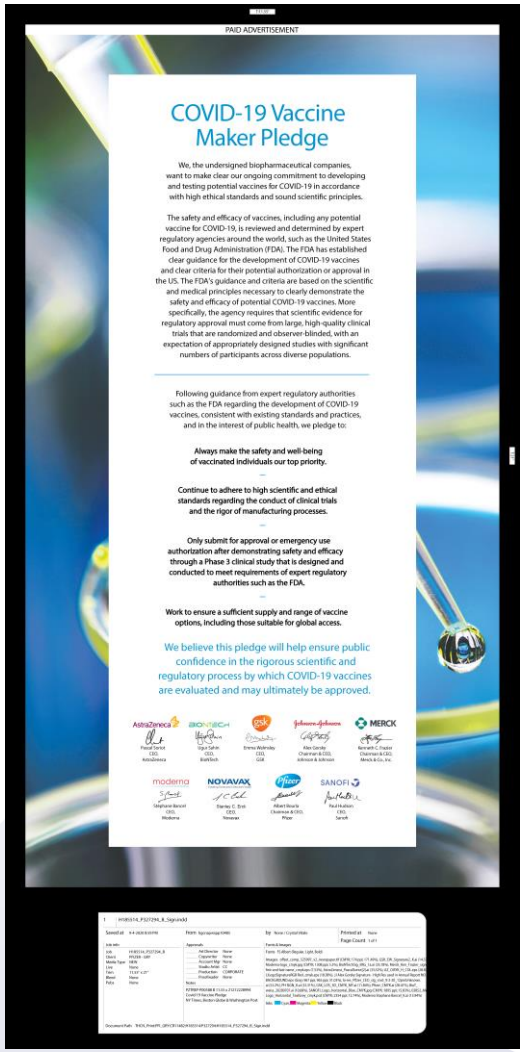
INDUSTRY COMMITMENT TO SCIENTIFIC RIGOR, TRANSPARENCY AND DIVERSITY

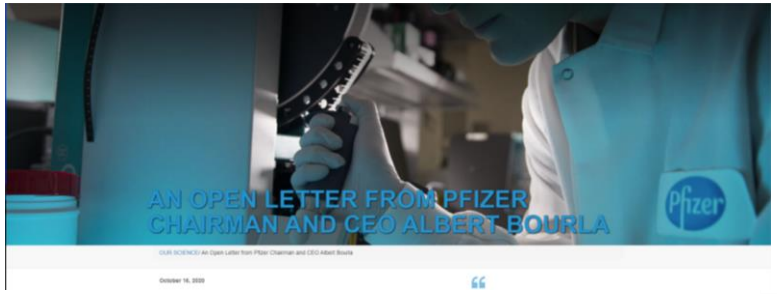
- Companies post weekly Phase 3 enrollment updates with break-down in diversity
- Companies publicly share information on clinical pauses or holds related to safety issues
- Companies have been submitting data for all trials for rapid peer-review by scientific journals and sharing more extensive scientific data in press releases closer to publication



INDUSTRY COMMITMENT TO SCIENTIFIC RIGOR, TRANSPARENCY AND DIVERSITY

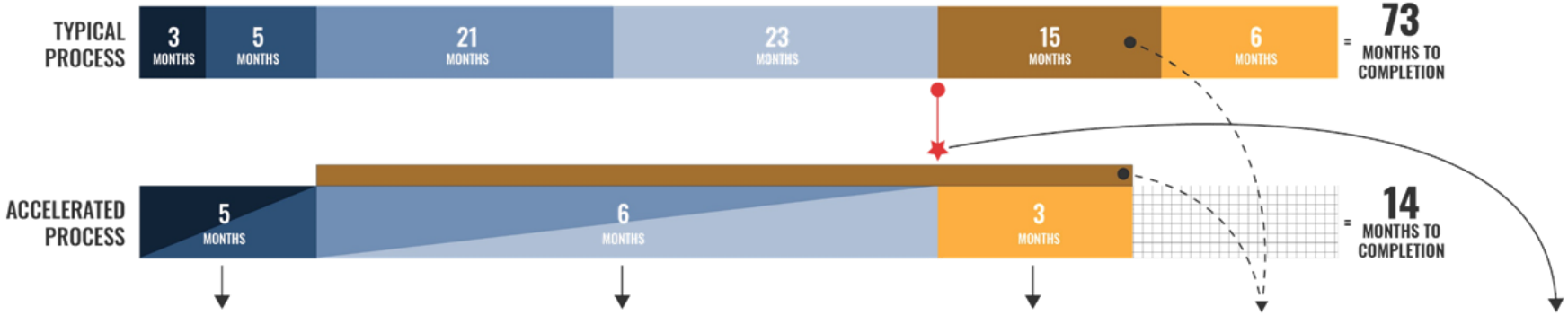
- September 3rd - BIO leadership principles - open letter to the biopharmaceutical industry
- September 4th – Moderna slows enrollment in Phase 3 trial to increase diversity in the trials
- September 8th – Biopharmaceutical companies (CEOs) public pledge on scientific rigor, evidence and safety
- September 19th – 20th – companies released clinical trial protocols
- October 1st – BIO Letter to Secretary Azar to support the release EUA guidance on COVID-19 vaccines
- October 16th – Pfizer Chairman and CEO Albert Bourla open letter on their COVID-19 vaccine





OPERATION WARP SPEED
ACCELERATED VACCINE PROCESS

MISSION: Deliver 300 million doses of safe and effective vaccine by 1 January 2021.



1

A typical 8-month process is accelerated by:

- Creating vaccine candidates immediately after viral genome sequence is available.
- Using vaccine platforms developed for other diseases.

2

A typical 42-month process is accelerated by:

- Large scale Phase III clinical trials of 30,000 volunteers allowing for rapid collection and earlier analysis of safety and efficacy data of demographically diverse populations by the FDA, reducing the typical 12-month approval process to three months.
- Two promising candidates began Phase III clinical trials in July, with others to follow quickly in coming months. Before beginning Phase III, candidates must show safety data from animal and human studies.
- The U.S. Government funding at-risk, large-scale manufacturing of the most promising vaccine candidates during Phase III clinical trials to ensure any vaccine proven to be safe and effective is available immediately upon FDA Emergency Use Authorization (EUA) approval or licensure.

4

A typical 6-month process is accelerated by:

- A tiered approach based on CDC recommended allocation methodology used as part of pandemic flu planning and the COVID-19 response will be used to determine vaccine distribution.

3

A typical 15-month process is accelerated by:

- Planning for infrastructure and distribution before the vaccines are approved or authorized.
- CDC leading distribution planning with DoD augmentation.

5

A typical 12-month FDA review for EUA approval or licensure is accelerated by:

- Providing continuous safety and efficacy data collected in large Phase III clinical trials.

R&D + Preclinical Trials Vaccine Candidate/s Identified
Phase I Clinical Trials
Phase II Clinical Trials
Phase III Clinical Trials
Manufacturing
Distribution

REGULATORY PATHWAYS FOR COVID-19 MEDICINES

- **Emergency Use Authorization (EUA):** The legal threshold for FDA to grant an EUA is that a product may be effective, and its benefits outweigh known and potential risks
  - In the past EUA has only been used for products for priority bio-threats such as smallpox and anthrax
  - In these instances, the product data is primarily efficacy in animals and safety in humans
  - Medicines would be used in the instance of a bioterror attack
- **Biologics License Application (BLA):** **Full licensure granted** if FDA determines there is substantial evidence of safety and effectiveness from adequate and well-controlled trials.

COVID-19 VACCINES: REGULATORY PATHS FORWARD

	BLA (Biologics License Application)	EUA (Emergency Use Authorization)
Efficacy for vaccines	• RCT 30,000 participants • 50% threshold for efficacy with a 30% adjusted lower confidence interval bound	• Interim analysis • 50% threshold for efficacy with a 30% adjusted lower confidence interval bound
Safety Database	At least 3000 patients	At least 3000 patients ; **ideally at least 5 severe COVID-19 cases in placebo group**
Follow up period	**"should continue as long as feasible, ideally at least one to two years"**	**"should include a median follow-up duration of at least two months after completion of the full vaccination regimen"**

- Regulatory requirements for EUA of COVID-19 vaccines are very similar to requirements for BLA of COVID- 19 vaccines.
- Primary differences are in period of follow up and some requirements on manufacturing inspections.
- FDA EUA Guidance clearly states that Agency does not see an EUA as reason to unblind ongoing randomized placebo-controlled trials

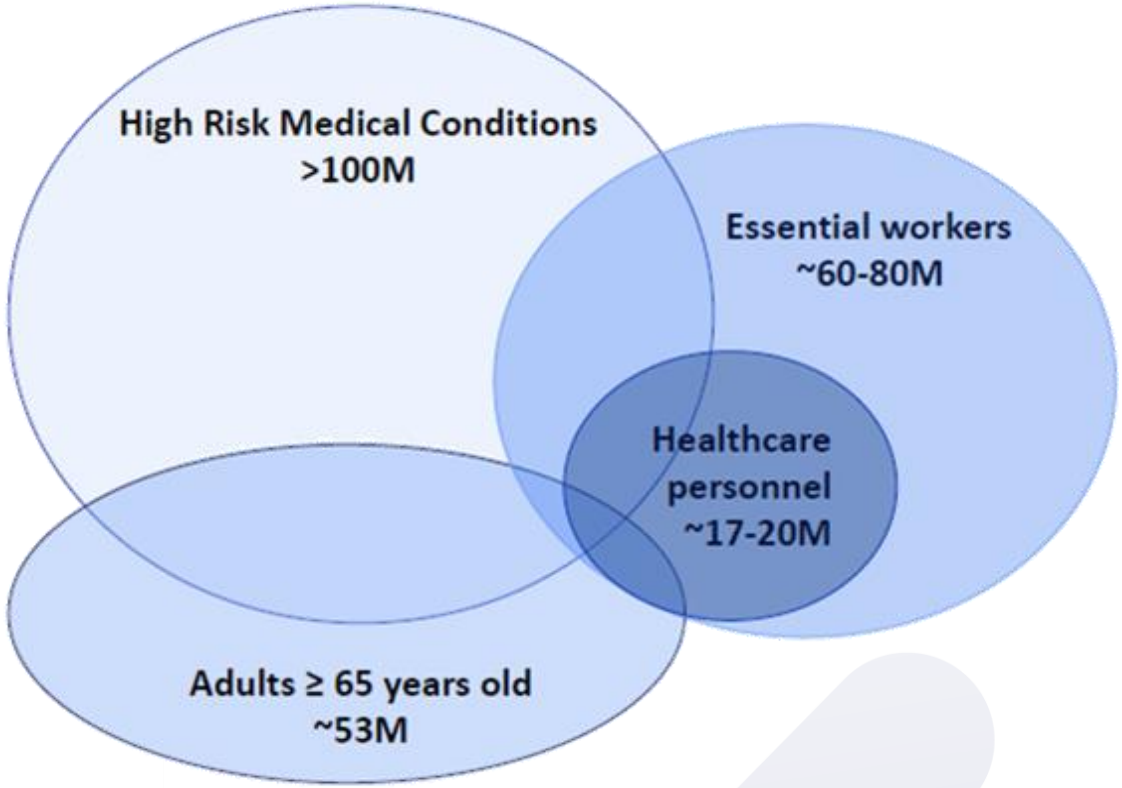
BUILDING VACCINE MANUFACTURING CAPACITY THROUGH PARTNERSHIPS

- Vaccine developers are producing COVID-19 vaccine doses at risk while clinical trials are underway
- Manufacturers, working with governments and funders, focused rapidly on partnerships to increase manufacturing capacity
  - Moderna → Catalent and Lonza
  - Novavax → FujiFilm Diosynth and Serum Institute of India
  - Astra Zenenca → Emergent Biosolutions
- BARDA investments in manufacturing facilities helped rapidly expand U.S. capacity
- CEPI and BMGF investments globally will allow for rapid, equitable access to all regions
- Global manufacturers like J&J and Pfizer are leveraging multiple existing production sites or investing in new facilities worldwide to provide doses in record time and increase worldwide capacity

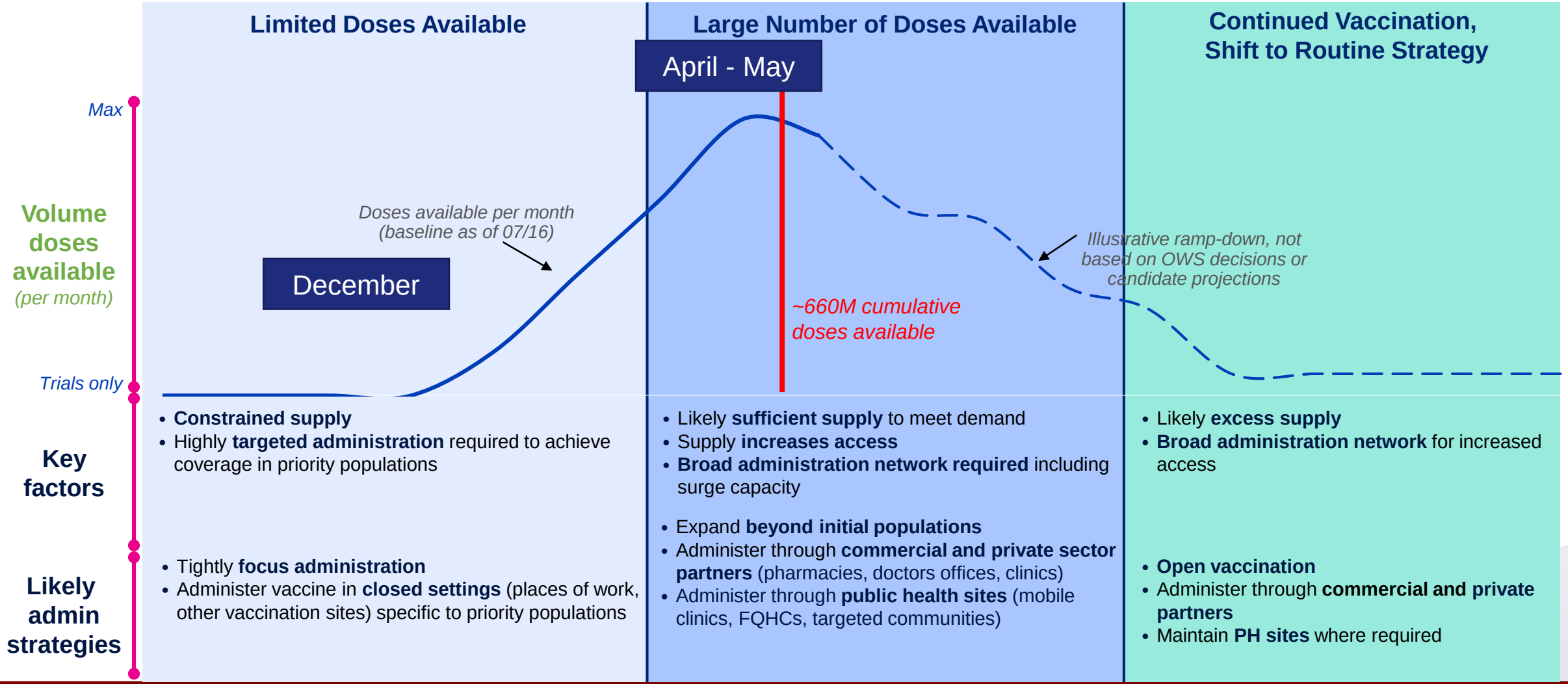
ACIP PRIORITIZATION FRAMEWORK

Groups prioritized for early phase vaccination

- ❑ Overlapping groups with significant heterogeneity
- ❑ Communities of color are significant portion of each population
- ❑ Accounts for > half of U.S. adults
- ❑ Framework informed by National Academies and Johns Hopkins frameworks

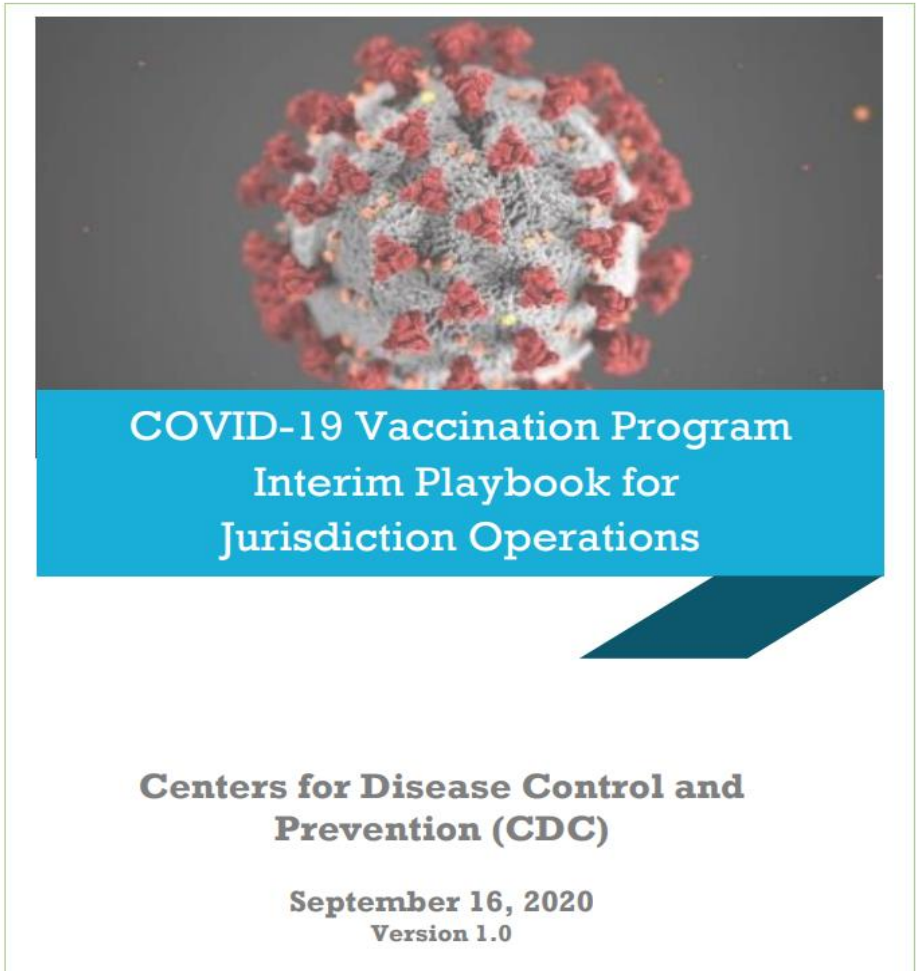


DISTRIBUTION WILL ADJUST AS VOLUME OF VACCINE DOSES INCREASES



Pre-Decisional & Deliberative *- Illustrative scenario for planning purposes; will be adapted based on the clinical / manufacturing information on all OWS candidates and vaccine prioritization*

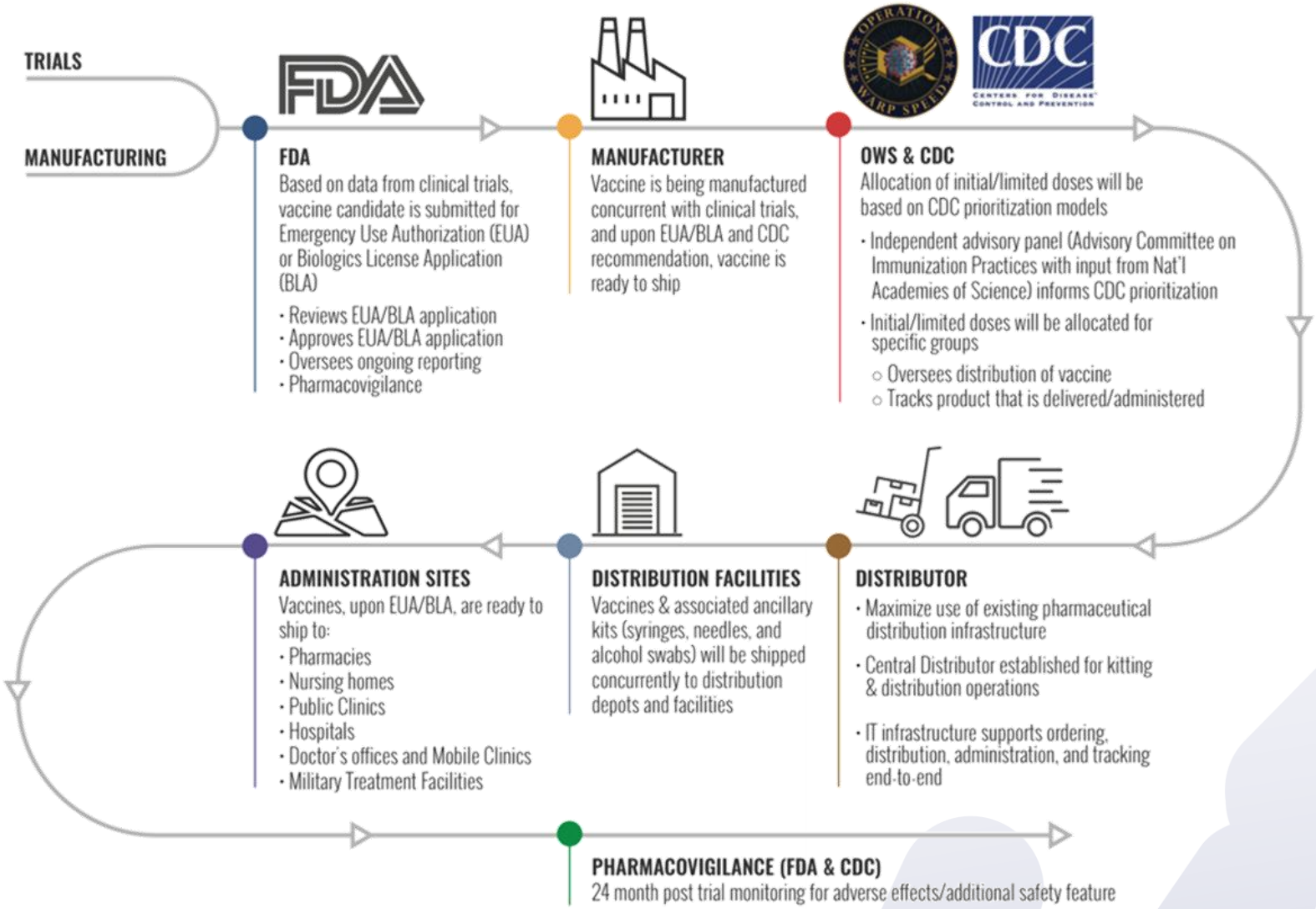
OWS / CDC JURISDICTIONAL "PLAYBOOK" LEADS TO STATE PLANS



- CDC Playbook released September 16th
  - Locating Critical Populations
  - Vaccination Provider Recruitment, Enrollment and Training
  - Vaccination Program Communication
  - Vaccine Ordering and Distribution
  - Vaccine Storage and Handling (preliminary)
  - Vaccine Safety Monitoring (preliminary)
  - CDC Dashboards
- State and jurisdictional plans submitted to CDC October 16th
  - Many states established distribution / implementation committees
  - Several states established clinical review committees

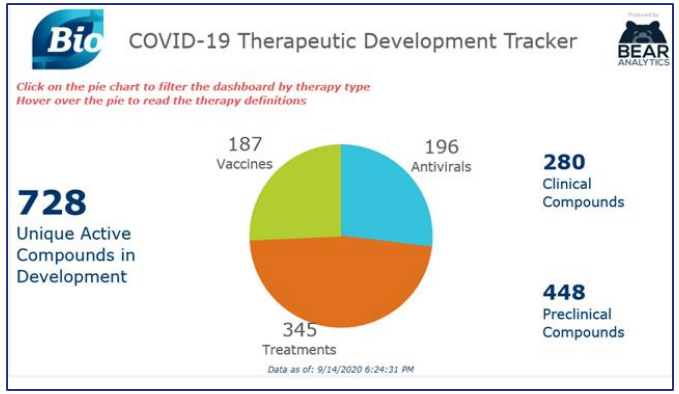
https://www.cdc.gov/vaccines/imz-managers/downloads/COVID-19-Vaccination-Program-Interim_Playbook.pdf

OWS VACCINES DISTRIBUTION PROCESS

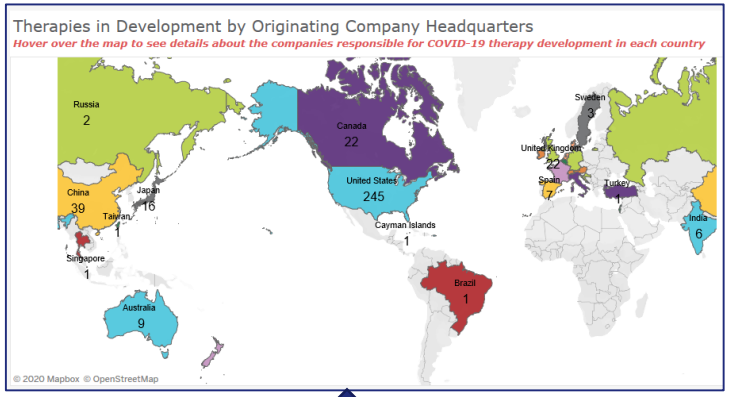


BIO COVID-19 PIPELINE TRACKER

Summary of Active Programs - by Type



Interactive Map - by Originating Country



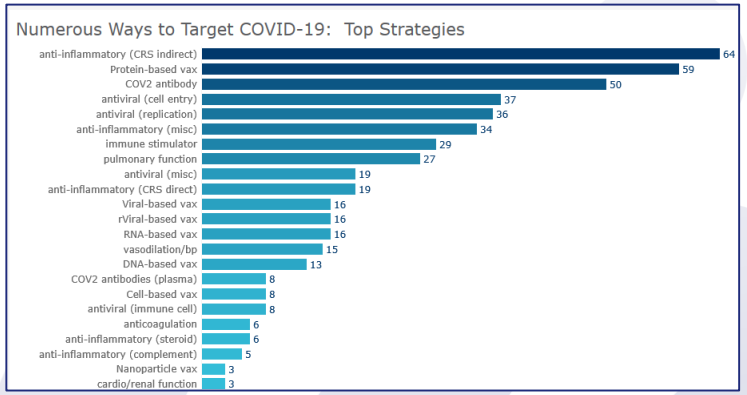
www.bio.org/covidpipelinetracker

Most Advanced Drug Programs

Most Advanced COVID-19 Antiviral Candidates

Drug	Sponsors, Partners, [Funding]	Phase	Repurposed, Redirected, New	Target family
umifenovir (Arbidol)	Multiple, Ruijin Hospital	Phase IV	Repurposed	neuraminidase
danoprevir + ritonavir	Roche, Ascletis/Roche (Ganovo/Danoprevir), ..	Phase IV	Repurposed	protease
carrimycin	Shenyang Tonglian	Phase IV	Repurposed	macrolide
camostat (Foipan)	University of Aarhus, Heinrich-Heine University	Phase IV	Repurposed	protease
baloxavir marboxil (Xofluza)	The First Hospital Affiliated to Zhejiang Unive..	Phase IV	Repurposed	polymerase
azithromycin	Multiple	Phase IV	Repurposed	macrolide
oseltamivir (Tamiflu)	Multiple, Tongji Hospital, Rajavithi Hospital, U..	Phase III	Repurposed	neuraminidase
nitazoxanide (Alinia)	Romark Laboratories, Lupin, Materno-Perinat..	Phase III	Repurposed	oxidoreductase
favipiravir	.decimal, Inc., Zhejiang Hisun Pharma	Phase III	Repurposed	polymerase
ENU200	Ennaid Therapeutics	Phase III	Repurposed	ACE2/Spike
emtricitabine + tenofovir di..	Plan Nacional sobre el Sida (PNS)	Phase III	Repurposed	reverse transcriptase
ASC09 + ritonavir	J&J, Ascletis Pharma	Phase III	Redirected	protease
Leronlimab	CytoDyn, Inc., Vyera Pharmaceuticals	Phase II/III	Redirected	CCR Family
Hyperimmune plasma	Foundation IRCCS San Matteo Hospital	Phase II/III	New for C19	COV2 epitope
Convalescent Plasma	Multiple	Phase II/III	New for C19	COV2 epitope
Xpovio	Karyopharm Therapeutics	Phase II	Repurposed	exportin
selinexor	Karyopharm	Phase II	Repurposed	exportin
ribavirin (Virazole)	Bausch Health Companies Inc.	Phase II	Repurposed	IMPDH
PP-001	4SC Aq, Panoptes Pharma	Phase II	Redirected	DHODH
piclidenoson	Can-Fite BioPharma, Temple University	Phase II	Redirected	adenosine pathway
merimepodib (Vicromax)	BioSig	Phase II	Redirected	IMPDH
lonafarnib (Sarasar)	Eiger BioPharmaceuticals	Phase II	Redirected	Farnesyl transferase
IMU-838	Immunic, Inc., 4SC AG	Phase II	Redirected	DHODH
galidesivir	BioCryst, [NIH/NIAID]	Phase II	Redirected	polymerase
FW-1022 (niclosamide)	FirstWave	Phase II	Repurposed	NA
FP-025	ForeSee	Phase II	Redirected	protease
Fludase	Ansun BioPharma, Wuhan University	Phase II	Redirected	surface glycans
elsulfavirine (Elpida)	Viriom LLC, Roche, Chinese CDC, Ministry of ..	Phase II	Redirected	reverse transcriptase
bemcentinib	BerGenBio AS, [Department of Health and So..	Phase II	Redirected	kinase inhibition
azvudine	Zhengzhou Granlen PharmaTech	Phase II	Redirected	reverse transcriptase
Aplidin	PharmaMar, S.A., Centro Nacional de Biotecn..	Phase II	Repurposed	translation

Top Drug Strategies



COLORADO BIOSCIENCE ASSOCIATION

BUILDING VACCINE CONFIDENCE

ANDREW POWALENY

DIRECTOR, PUBLIC AFFAIRS

PhRMA

RESEARCH • PROGRESS • HOPE

PHRMA'S VACCINE RESOURCES: PhRMA.org/coronavirus & PhRMA.org/vaccines

Safety & Effectiveness

Approaches

Clinical Trials

Industry Role in Ecosystem

COLORADO BIOSCIENCE ASSOCIATION

Bio Biotechnology Innovation Organization

THANK YOU

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Director, State Government Affairs
bwarren@bio.org