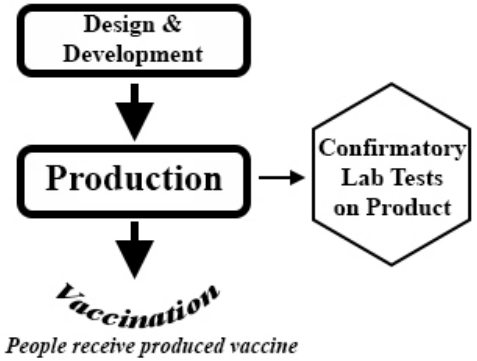
CHARLOTTE LOZIER INSTITUTE

Update: COVID-19 Vaccine Candidates and Abortion-Derived Cell Lines

Accurate information about the development and production of COVID-19 vaccines is essential, especially because many proposed candidates use newer molecular technologies for production of a viral vaccine. One concern regarding the ethical assessment of viral vaccine candidates is the potential use of abortion-derived cell lines in the development, production or testing of a vaccine. This analysis utilizes data from the primary scientific literature when available, along with data from clinical trial documents, reputable vaccine tracking websites, and published commercial information.[1] It is the hope that by providing accurate data, recipients can make well-informed decisions regarding vaccine choices.

For additional background and guidance, please see:
* A Visual Aid to Viral Infection and Vaccine Production for a visual primer on the various strategies for viral vaccine production.
* An Ethics Assessment of COVID-19 Vaccine Programs for discussion of ethical considerations in viral vaccine production.
* COVID-19 Vaccines & Fetal Cell Lines for an infographic description of how fetal cell lines are sometimes used to produce vaccines.



Flow Chart for Creation and Testing of Vaccines
Design & Development: conceptualization, preparatory experiments, and specification for how vaccine will be constructed and produced.
Production: process used to manufacture final vaccine to be given to people.
Confirmatory Lab Tests on Product: tests to analyze quality, nucleic acid or protein sequence, protein conformation, antibody reactivity, etc. of final vaccine product.
Vaccination: giving final produced vaccine to people.

Analysis of SARS-CoV-2 (COVID-19) Vaccine Candidates

Last Updated 30 September 2020

DOES NOT USE abortion-derived cell line

DOES USE abortion-derived cell line

SOME tests DO NOT use abortion-derived cells, SOME DO.

[BLANK] Currently undetermined

Sponsor(s)[1]	Country	Strategy[2]	Clinical Trial Status[3]	Public Funding[4]	Design & Development	Production	Confirm-atory Lab Tests
WHOLE VIRUS VACCINE – LIVE ATTENUATED or INACTIVATED							
Beijing Institute of Biological Products/ Sinopharm	China	Inactivated virus "BBIBP-CorV" Given: Intramuscular	**Phase 3** **Phase 1/2**		Vero monkey cells	Vero monkey cells	

Wuhan Institute of Biological Products/ Sinopharm	China	Inactivated virus Unnamed Given: Intramuscular	**Phase 3** **Phase 1/2**		Vero monkey cells	Vero monkey cells Xia *et al.*, *JAMA* 324, 951, 13Aug2020	
John Paul II Medical Research Institute	USA	Live attenuated virus	Pre-clinical		Ethical cell lines as a matter of policy	Perinatal human cells (term umbilical cord and placental)	
Sinovac Biotech Co., Ltd.	China	Inactivated virus "PiCoVacc" Given: Intramuscular	**Phase 3** **Phase 3** **Phase 1/2** **Phase 1/2** **Phase 1/2**		Vero monkey cells	Vero monkey cells Gao *et al.*, *Science* 369, 77, 3July2020	protein test HEK293 cells Supplement Gao *et al.*, *Science* 369, 77, 3July2020
VIRAL VECTOR-BASED VACCINE							
Altimmune	USA	Replication-deficient Adenovirus vector "AdCOVID" Given: Intranasal	Pre-clinical		PER.C6 cells	PER.C6 cells Same platform as NasoVAX NasoVAX uses PER.C6 Licensed PER.C6 from Janssen	
AstraZeneca University of Oxford	USA UK	Replication-deficient Adenovirus vector "AZD1222" "ChAdOX1nCoV-19" Given: Intramuscular	**Phase 3** **Phase 3** **Phase 3** **Phase 2/3** **Phase 2/3** **Phase 1/2** **Phase 1/2**	*Operation Warp Speed* HHS-BARDA $1.2 Billion CEPI up to $384 Million	HEK293 cells	HEK293 cells van Doremalen *et al.*, *Nature* preprint, 30July2020	
CanSino Biologics, Inc. Beijing Institute of Biotechnology, Academy of Military Medical Sciences, PLA of China	China	Replication-deficient Adenovirus vector "Ad5-nCoV" Given: Intramuscular	**Phase 3** **Phase 3** **Phase 2** **Phase 2** **Phase 2** **Phase 1** **Phase 1**		HEK293 cells	HEK293 cells Biospace, 12May2020	
Gamaleya Research Institute	Russia	Replication-deficient Adenovirus vectors	**Phase 3**		HEK293 cells	HEK293 cells	

		(rAd26-S+rAd5-S) "Sputnik V" Given: Intramuscular	*Early approval in Russia August 2020* **Phase 1/2** **Phase 1/2**				
Institut Pasteur and Themis and Merck	USA France	Replication-competent recombinant measles virus "TMV-083" Given: Intramuscular	**Phase 1**	CEPI up to $4.9 Million		Vero monkey cells	
Janssen Research & Development, Inc. Johnson & Johnson	USA	Replication-deficient Adenovirus vector "Ad26" Given: Intramuscular	**Phase 3** **Phase 1/2**	*Operation Warp Speed* HHS-BARDA $1,457,887,081 total	PER.C6 cells	PER.C6 cells Tostanoski *et al., Nature Medicine,* 3Sept2020; J&J, 30March2020; Janssen Vaccine Technologies	
Merck and IAVI	USA	Replication-competent recombinant vesicular stomatitis virus (VSVΔG) "V590" Given: Intramuscular	Pre-clinical	*Operation Warp Speed* HHS-BARDA $38,033,570	Vero monkey cells	Vero monkey cells Use rVSV Ervebo platform Ervebo uses Vero cell culture-11 Description	
Shenzhen Geno-immune Medical Institute	China	Lentivirus minigenes + Adult human APC (antigen-presenting cells)	**Phase 1**				
Shenzhen Geno-immune Medical Institute	China	Lentivirus minigenes + Adult human CD/T cells (dendritic cells and T cells) "LV-SMENP-DC"	**Phase 1/2**				
Vaxart	USA	Replication-deficient Adenovirus vector "VXA-CoV2-1" plus dsRNA adjuvant Given: Oral	**Phase 1**		HEK293 cells	HEK293 cells Moore *et al., bioRxiv 6Sept2020*	
PROTEIN-BASED VACCINE							

Clover Biopharmaceuticals, Inc.	China	Protein vaccine "SCB-2019" plus adjuvant CpG 1018 Given: Intramuscular	**Phase 1**	CEPI up to $69.5 Million		CHO hamster cells Trimer-Tag system; Liu *et al., Scientific Reports* 2017	
John Paul II Medical Research Institute	USA	Recombinant Protein Perinatal human cells (term umbilical cord and placental)	Pre-clinical		Ethical cell lines as a matter of policy	Perinatal human cells (term umbilical cord and placental)	
Novavax	USA	Protein vaccine "NVX-CoV2373" Baculovirus expression plus Matrix M adjuvant Given: Intramuscular	**Phase 2** **Phase 1**	*Operation Warp Speed* HHS-BARDA $1,600,434,523 CEPI up to $388 Million		Sf9 insect cells Bangaru *et al.*, *bioRxiv* preprint, 6Aug2020; Graphical view	Pseudovirus HEK293 cells Bangaru *et al.*, *bioRxiv* preprint, 6Aug2020
Sanofi and GSK Protein Sciences	USA France	Protein vaccine Baculovirus expression plus AS03 adjuvant Given: Intramuscular	**Phase 1/2**	*Operation Warp Speed* HHS-BARDA $2,072,775,336 total		Sf9 insect cells Baculovirus expressed recombinant protein ;	
Sorrento	USA	Protein vaccine "T-VIVA-19" SARS-Cov-2 spike protein S1 domain fused with human IgG-Fc Given: Intramuscular	Pre-clinical			CHO cells Herrmann *et al.*, *bioRxiv* preprint, 30June2020	
Sorrento	USA	Protein vaccine "STI-6991" SARS-Cov-2 spike protein expressed on K562 cells	Pre-clinical			K562 cells Concept: Ji *et al.*, *Medicine in Drug Discovery* March2020	
University of Pittsburgh	USA	Protein vaccine Adenovirus-expressed recombinant proteins "PittCoVacc" Given: Microneedle arrays	Pre-clinical		HEK293 cells	HEK293 cells Kim *et al.*, *EBioMedicine* , 2April2020	
University of Queensland and CSL Ltd.	Australia	Protein vaccine "V451"	**Phase 1** **Phase 1**	CEPI up to $4.5 Million			

		Recombinant protein with proprietary molecular clamp Given: Intramuscular	**Phase 1**			expiCHO hamster cells	
RNA VACCINE							
Arcturus Therapeutics	USA	mRNA vaccine self-transcribing, replicating "LUNAR-CoV19" ("ARCT-021") *in vitro* transcription reaction with T7 RNA polymerase from STARR plasmid template LUNAR proprietary lipid nanoparticle encapsulated Given: Intramuscular	**Phase 1/2**		Sequence designed on computer	No cells used de Alwis *et al.*, *bioRxiv* 3Sept2020	protein test de Alwis *et al.*, *bioRxiv* 3Sept2020
CureVac	Germany	mRNA vaccine non-replicating Given: Intramuscular	**Phase 2** **Phase 1**	CEPI up to $15.3 Million		No cells used	
Moderna, Inc. with National Institutes of Health	USA	mRNA vaccine non-replicating "mRNA-1273" T7 RNA polymerase-mediated transcription from DNA plasmid template LNP (lipid nanoparticle) encapsulated Given: Intramuscular	**Phase 3** **Phase 2** **Phase 1**	*Operation Warp Speed* HHS-BARDA $2,479,894,979 total CEPI up to $1 Million	Sequence designed on computer	No cells used Corbett *et al.*, *Nature* , 5Aug2020	protein test & pseudovirus HEK293 cells Corbett *et al.*, *Nature* , 5Aug2020
Pfizer and BioNTech	USA Germany	mRNA vaccine non-replicating "BNT-162a1,b1,b2,b3,c2" nucleoside-modified mRNA *in vitro* transcribed by T7	**Phase 2/3** **Phase 1/2** **Phase 1/2** **Phase 1** **Phase 1**	*Operation Warp Speed* HHS-BARDA $1.95 Billion	Sequence designed on computer	No cells used Vogel *et al.*, *bioRxiv* 8Sept2020	protein test & pseudovirus HEK293 cells Vogel *et al.*, *bioRxiv* 8Sept2020

		polymerase from a plasmid DNA template LNP (lipid nanoparticle) encapsulated Given: Intramuscular					
Sanofi Pasteur and Translate Bio	USA France	mRNA vaccine non-replicating Given: Intramuscular	Pre-clinical		 Sequence designed on computer	 No cells used mRNA production in the lab ; Translate Bio scientific platform	
DNA VACCINE							
Inovio Pharmaceuticals	USA	DNA vaccine "INO-4800" DNA synthesized in vitro, placed in plasmid vector Given: Intradermal Electroporation	**Phase 1/2** **Phase 1**	*Operation Warp Speed* CEPI up to $22.5 Million	 Sequence designed on computer	 No cells used Smith *et al.*, *Nature* 20May2020	 protein test & pseudovirus HEK293 cells Smith *et al.*, *Nature* 20May2020
Symvivo Corporation	Canada	DNA vaccine Genetically engineered *Bifidobacterium longum* "bacTRL-spike" Given: Oral, bacteria bind to gut lining	**Phase 1**			 No cells used	

1. Data accumulated from primary literature as referenced in the Chart; AND "COVID-19 Treatment and Vaccine Tracker," Milken Institute, https://covid-19tracker.milkeninstitute.org/ ; AND "Draft landscape of COVID-19 candidate vaccines," World Health Organization (WHO), https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines
NOTE that patents are not considered because they are unreliable sources; even the most relevant patents are prospective documents that provide examples of potential use, but do not provide information about actual, current application of an invention or technology.
2. Prentice, DA and Sander Lee, T. June 15, 2020. A Visual Aid to Viral Infection and Vaccine Production. *On Science Series 1. Accessed 19 June 2020* at: https://lozierinstitute.org/a-visual-aid-to-viral-infection-and-vaccine-production/
3. Phases of Clinical Trials: Pre-clinical- laboratory and animal studies; Phase I- 10-100 people, study safety and dosage; Phase II- tens to hundreds of people, study efficacy, dosage, side effects; Phase III- hundreds to thousands of people, study efficacy and adverse reactions.
4. HHS-BARDA = U.S. Health and Human Services-Biomedical Advanced Research and Development Authority; CEPI = Coalition of Epidemic Preparedness Innovations; BARDA's rapidly-expanding COVID-19 medical countermeasure portfolio. *Accessed 29 Sept 2020* at https://www.medicalcountermeasures.gov/app/barda/coronavirus/COVID19.aspx; CEPI's COVID-19 Vaccine Portfolio, *Accessed 29 Sept 2020* at https://cepi.net/COVAX/