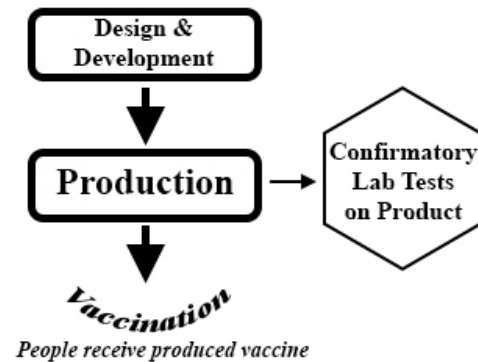


## Update: COVID-19 Vaccine Candidates and Abortion-Derived Cell Lines

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.<sup>1</sup> 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.












<b><u>Analysis of SARS-CoV-2 (COVID-19) Vaccine Candidates</u></b> <i>Last Updated 10 November 2020</i>					 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) <sup>1</sup>	Country	Strategy <sup>2</sup>	Clinical Trial Status <sup>3</sup>	Public Funding <sup>4</sup>	Design & Development	Production	Confirmatory Lab Tests	
<b>WHOLE VIRUS VACCINE – LIVE ATTENUATED or INACTIVATED</b>								
Beijing Institute of Biological Products/ Sinopharm	China	Inactivated virus “BBIBP-CorV” Given: Intramuscular	<a href="#">Phase 3</a> <a href="#">Phase 1/2</a>		 Vero monkey cells	 Vero monkey cells		





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

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

Anhui Zhifei Longcom Biopharmaceutical/Institute of Microbiology, Chinese Academy of Sciences	China	Protein vaccine Recombinant RBD dimer plus adjuvant Given: Intramuscular	<a href="#">Phase 2</a> <a href="#">Phase 1/2</a> <a href="#">Phase 1</a>		 HEK293T cells <a href="#">Dai et al., Cell</a> 6Aug2020	 CHO hamster cells <a href="#">Dai et al., Cell</a> 6Aug2020	 Pseudovirus HEK293T cells <a href="#">Dai et al., Cell</a> 6Aug2020
Clover Biopharmaceuticals, Inc.	China	Protein vaccine “SCB-2019” plus adjuvant CpG 1018 Given: Intramuscular	<a href="#">Phase 1</a>	CEPI up to \$69.5 Million		 CHO hamster cells <a href="#">Trimer-Tag system; Liu et al., Scientific Reports</a> 2017	
John Paul II Medical Research Institute	USA	Recombinant Protein Perinatal human cells (term umbilical cord and placental)	Pre-clinical		 <a href="#">Ethical cell lines as a matter of policy</a>	 <a href="#">Perinatal human cells (term umbilical cord and placental)</a>	
Medicago	Canada	Protein on Virus-Like Particle “CoVLP” Plant-expressed spike protein particle with adjuvant, CpG1018 or AS03 Given: Intramuscular	<a href="#">Phase 1</a>		 Recombinant DNA sequence in <i>Agrobacterium</i> , transformation of plant cells	 Plant expression of protein and VLP <a href="#">Ward et al., medRxiv</a> 6Nov2020	 Pseudovirus HEK293 cells <a href="#">Ward et al., medRxiv</a> 6Nov2020
Novavax	USA	Protein vaccine “NVX-CoV2373” Baculovirus expression plus Matrix M adjuvant Given: Intramuscular	<a href="#">Phase 3</a> <a href="#">Phase 2</a> <a href="#">Phase 1</a>	<i>Operation Warp Speed</i> HHS-BARDA \$1,600,434,523 CEPI up to \$388 Million		 Sf9 insect cells <a href="#">Bangaru et al., bioRxiv preprint</a> , 6Aug2020; <a href="#">Graphical view</a>	 Pseudovirus HEK293 cells <a href="#">Bangaru et al., bioRxiv preprint</a> , 6Aug2020
Sanofi and GSK Protein Sciences	USA France	Protein vaccine Baculovirus expression plus AS03 adjuvant Given: Intramuscular	<a href="#">Phase 1/2</a>	<i>Operation Warp Speed</i> HHS-BARDA \$2,072,775,336 total		 Sf9 insect cells <a href="#">Baculovirus expressed recombinant protein</a> ;	
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 <a href="#">Herrmann et al., bioRxiv preprint</a> , 30June2020	

Sorrento	USA	Protein vaccine “STI-6991” SARS-Cov-2 spike protein expressed on K562 cells	Pre-clinical			 K562 cells <a href="#">Concept: Ji et al., Medicine in Drug Discovery March2020</a>	
University of Pittsburgh	USA	Protein vaccine Adenovirus-expressed recombinant proteins “PittCoVacc” Given: Microneedle arrays	Pre-clinical		 HEK293 cells	 HEK293 cells <a href="#">Kim et al., EBioMedicine, 2April2020</a>	
University of Queensland and CSL Ltd.	Australia	Protein vaccine “V451” Recombinant protein with proprietary molecular clamp Given: Intramuscular	<a href="#">Phase 1</a> <a href="#">Phase 1</a> <a href="#">Phase 1</a>	CEPI up to \$4.5 Million		 expiCHO hamster cells	
<b>RNA VACCINE</b>							
Arcturus Therapeutics	USA	mRNA vaccine self-transcribing, replicating “LUNAR-CoV19” (“ARCT-021”) <i>in vitro</i> transcription reaction with T7 RNA polymerase from STARR plasmid template LUNAR proprietary lipid nanoparticle encapsulated Given: Intramuscular	<a href="#">Phase 1/2</a>		 Sequence designed on computer	 No cells used <a href="#">de Alwis et al., bioRxiv 3Sept2020</a>	 protein test <a href="#">de Alwis et al., bioRxiv 3Sept2020</a>
CureVac	Germany	mRNA vaccine non-replicating “CVnCoV” <i>in vitro</i> transcription lipid nanoparticle encapsulated Given: Intramuscular	<a href="#">Phase 2</a> <a href="#">Phase 1</a>	CEPI up to \$15.3 Million	 Sequence designed on computer	 No cells used <a href="#">Rauch et al., bioRxiv 23Oct2020</a>	 Protein test Reticulocyte lysate, HeLa cells <a href="#">Rauch et al., bioRxiv 23Oct2020</a>

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	<a href="#">Phase 3</a> <a href="#">Phase 2</a> <a href="#">Phase 1</a>	<i>Operation Warp Speed</i> HHS-BARDA \$2,479,894,979 total CEPI up to \$1 Million	 Sequence designed on computer	 No cells used <a href="#">Corbett et al., Nature , 5Aug2020</a>	 protein test & pseudovirus HEK293 cells <a href="#">Corbett et al., Nature , 5Aug2020</a>
Pfizer and BioNTech	USA Germany	mRNA vaccine non-replicating “BNT-162a1,b1,b2,b3,c2” nucleoside-modified mRNA <i>in vitro</i> transcribed by T7 polymerase from a plasmid DNA template LNP (lipid nanoparticle) encapsulated Given: Intramuscular	<a href="#">Phase 2/3</a> <a href="#">Phase 1/2</a> <a href="#">Phase 1/2</a> <a href="#">Phase 1</a> <a href="#">Phase 1</a>	<i>Operation Warp Speed</i> HHS-BARDA \$1.95 Billion	 Sequence designed on computer	 No cells used <a href="#">Vogel et al., bioRxiv 8Sept2020</a>	 protein test & pseudovirus HEK293 cells <a href="#">Vogel et al., bioRxiv 8Sept2020</a>
Sanofi Pasteur and Translate Bio	USA France	mRNA vaccine non-replicating “MRT5500” synthesized by <i>in vitro</i> transcription employing RNA polymerase with a plasmid DNA template LNP (lipid nanoparticle) encapsulated Given: Intramuscular	Pre-clinical		 Sequence designed on computer	 No cells used <a href="#">Kalnin et al., bioRxiv 14Oct2020</a> mRNA production in the lab ; <a href="#">Translate Bio scientific platform</a>	 protein test & pseudovirus HEK293 cells <a href="#">Kalnin et al., bioRxiv 14Oct2020</a>
<b>DNA VACCINE</b>							
Genexine	Korea	DNA vaccine “GX-19” DNA synthesized <i>in vitro</i> , placed in plasmid vector	<a href="#">Phase 1/2</a>		 Sequence designed on computer	 No cells used <a href="#">Seo et al., bioRxiv 10Oct2020</a>	

		Given: Intramuscular and Electroporation					
Inovio Pharmaceuticals	USA	DNA vaccine “INO-4800” DNA synthesized in vitro, placed in plasmid vector Given: Intradermal Electroporation	<a href="#">Phase 1/2</a> <a href="#">Phase 1</a>	<i>Operation Warp Speed</i> CEPI up to \$22.5 Million	 Sequence designed on computer	 No cells used <i>Smith et al., Nature</i> 20May2020	 protein test & pseudovirus HEK293 cells <i>Smith et al., Nature</i> 20May2020
Symvivo Corporation	Canada	DNA vaccine Genetically engineered <i>Bifidobacterium longum</i> “bacTRL-spike” Given: Oral, bacteria bind to gut lining	<a href="#">Phase 1</a>			 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/>