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The image shows a browser window with the address bar containing `pubmed.ncbi.nlm.nih.gov`. A red box highlights the address bar, and a red arrow points from the top of the page down to the search bar. The page features a pink banner with COVID-19 information, the NIH logo, the PubMed.gov logo, a search bar with a green 'Search' button, and a 'Log in' button in the top right. A 'Feedback' button is located in the bottom right corner.

COVID-19 is an emerging, rapidly evolving situation.
Get the latest public health information from CDC: <https://www.coronavirus.gov>.
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or

Enter/type the keywords/search for a research paper /item in the search bar/box(e.g. Covid Vaccine) and click on search

The image shows a screenshot of the PubMed website's search page. At the top, there is a navigation bar with the PubMed logo and the URL pubmed.ncbi.nlm.nih.gov. Below the navigation bar, there is a pink banner with text about COVID-19: "COVID-19 is an emerging, rapidly evolving situation. Get the latest public health information from CDC: <https://www.coronavirus.gov>. Get the latest research from NIH: <https://www.nih.gov/coronavirus>. Find NCBI SARS-CoV-2 literature, sequence, and clinical content: <https://www.ncbi.nlm.nih.gov/sars-cov-2/>." Below the banner, the NIH logo and "National Library of Medicine National Center for Biotechnology Information" are displayed on the left, and a "Log in" button is on the right. The main content area features the "PubMed.gov" logo. A search bar is located at the bottom, containing the text "Covid vaccine". A red box highlights the search bar, and a red arrow points from the text "Covid vaccine" in the instructions above to the search bar. To the right of the search bar is a green "Search" button, which is highlighted with a yellow box. A red arrow points from the text "click on search" in the instructions above to the "Search" button. Below the search bar, the word "Advanced" is visible. At the bottom of the page, there is a footer: "PubMed® comprises more than 30 million citations for biomedical literature from MEDLINE, life science journals, and online books. Citations may include links to full-text content from PubMed Central and publisher web sites."

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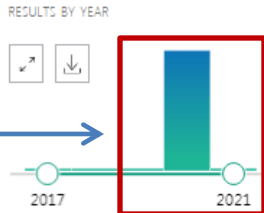
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1 **The COVID-19 Vaccine Race: Challenges and Opportunities in Vaccine Formulation.**
Wang J, Peng Y, Xu H, Cui Z, Williams RO 3rd.
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2 **Safety, tolerability, and immunogenicity of a recombinant adenovirus type-5 vectored COVID-19 vaccine: a dose-escalation, open-label, non-randomised, first-in-human trial.**
Zhu FC, Li YH, Guan XH, Hou LH, Wang WJ, Li JX, Wu SP, Wang BS, Wang Z, Wang L, Jia SY, Jiang HD, Wang L, Jiang T, Hu Y, Gou JB, Xu SB, Xu JJ, Wang XW, Wang W, Chen W.
Lancet. 2020 Jun 13;395(10240):1845-1854. doi: 10.1016/S0140-6736(20)31208-3. Epub 2020 May 22. PMID: 32450106 [Free PMC article.](#) [Clinical Trial.](#)
BACKGROUND: A vaccine to protect against COVID-19 is urgently needed. We aimed to assess the safety, tolerability, and immunogenicity of a recombinant adenovirus type-5 (Ad5) vectored COVID-19 vaccine expressing the spike glycoprotein of a severe acute ...

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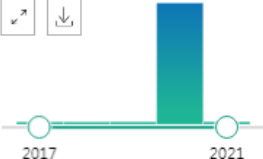
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1 **The COVID-19 Vaccine Race: Challenges and Opportunities in Vaccine Formulation.**

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Cite Zhu FC, Li YH, Guan XH, Hou LH, Wang WJ, Li JX, Wu SP, Wang BS, Wang Z, Wang L, Jia SY, Jiang HD, Wang L, Jiang T, Hu Y, Gou JB, Xu SB, Xu JJ, Wang XW, Wang W, Chen W. Lancet. 2020 Jun 13;395(10240):1845-1854. doi: 10.1016/S0140-6736(20)31208-3. Epub 2020 May 22. PMID: 32450106 [Free PMC article](#). Clinical Trial.

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The COVID-19 Vaccine Race: Challenges and Opportunities in Vaccine Formulation

Jieliang Wang¹, Ying Peng², Haiyue Xu¹, Zhengrong Cui¹, Robert O Williams 3rd³

Affiliations + expand
PMID: 32761294 PMCID: PMC7405756 DOI: 10.1208/s12249-020-01744-7
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Abstract

In the race for a safe and effective vaccine against coronavirus disease (COVID)-19, pharmaceutical formulation science plays a critical role throughout the development, manufacturing, distribution, and vaccination phases. The proper choice of the type of vaccine, carrier or vector, adjuvant, excipients,

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Review Article | Published: 05 August 2020

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Abstract

In the race for a safe and effective vaccine against coronavirus disease (COVID)-19, pharmaceutical formulation science plays a critical role throughout the development, manufacturing, distribution, and vaccination phases. The proper choice of the type of vaccine,

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Abstract

In the race for a safe and effective vaccine against coronavirus disease (COVID)-19, role throughout the development.

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Abstract

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The COVID-19 Vaccine Race: Challenges and Opportunities in Vaccine Formulation 1 / 12

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Review Article

The COVID-19 Vaccine Race: Challenges and Opportunities in Vaccine Formulation

Jieliang Wang,¹ Ying Peng,² Haiyue Xu,¹ Zhengrong Cui,¹ and Robert O. Williams III^{1,3}

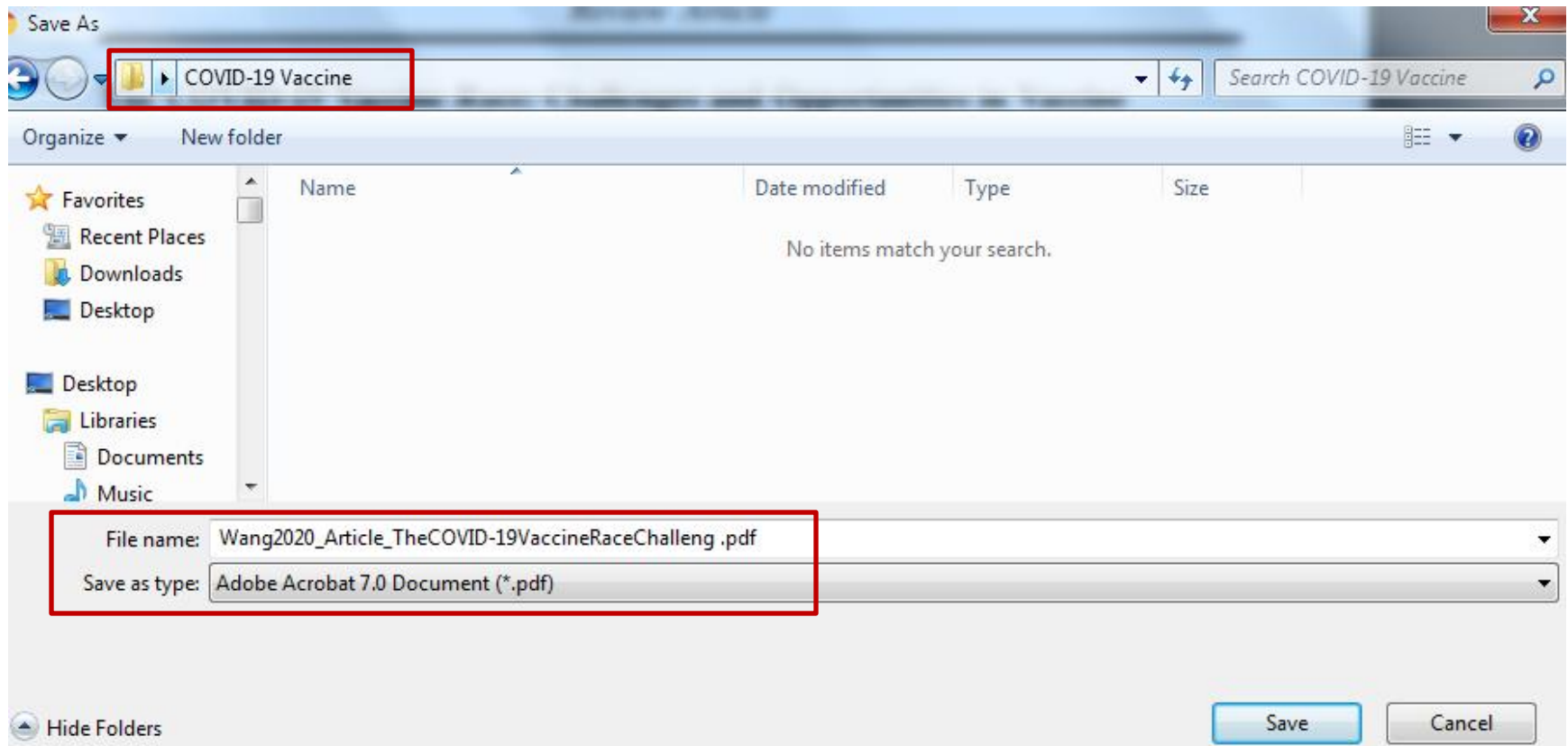
Received 1 June 2020; accepted 2 July 2020; published online 5 August 2020

Abstract. In the race for a safe and effective vaccine against coronavirus disease (COVID)-19, pharmaceutical formulation science plays a critical role throughout the development, manufacturing, distribution, and vaccination phases. The proper choice of the type of vaccine, carrier or vector, adjuvant, excipients, dosage form, and route of administration can directly impact not only the immune responses induced and the resultant efficacy against COVID-19, but also the logistics of manufacturing, storing and distributing the vaccine, and mass vaccination. In this review, we described the COVID-19 vaccines that are currently tested in clinical trials and provided in-depth insight into the various types of vaccines, their compositions, advantages, and potential limitations. We also addressed how challenges in vaccine distribution and administration may be alleviated by applying vaccine-stabilization strategies and the use of specific mucosal immune response-inducing, non-invasive routes of administration, which must be considered early in the development process.

KEY WORDS: coronavirus; vaccine; adjuvant; route of administration; mucosal vaccination.

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- Wang, J., Peng, Y., Xu, H., Cui, Z., Williams III, RO. The COVID-19 Vaccine Race: Challenges and Opportunities in Vaccine Formulation. AAPS PharmSciTech (2020) 21: 225. DOI: 10.1208/s12249-020-01744-7