

The COVID-19 pandemic has led to rapid advances in several vaccine technologies:



Vaccine platforms

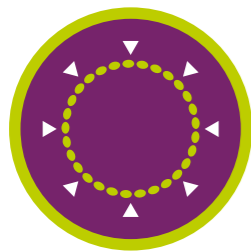


Adjuvants



Vaccine delivery systems

Particle-based delivery systems increase influenza candidate vaccine immunogenicity and stability,<sup>12</sup> for example:



Virus-like particles



Lipid nanoparticles



Self-assembling protein nanoparticles [e.g. ferritin]

Multiple influenza vaccines are in development across the non-traditional vaccine platforms:<sup>1-10</sup>



DNA vaccines



RNA vaccines



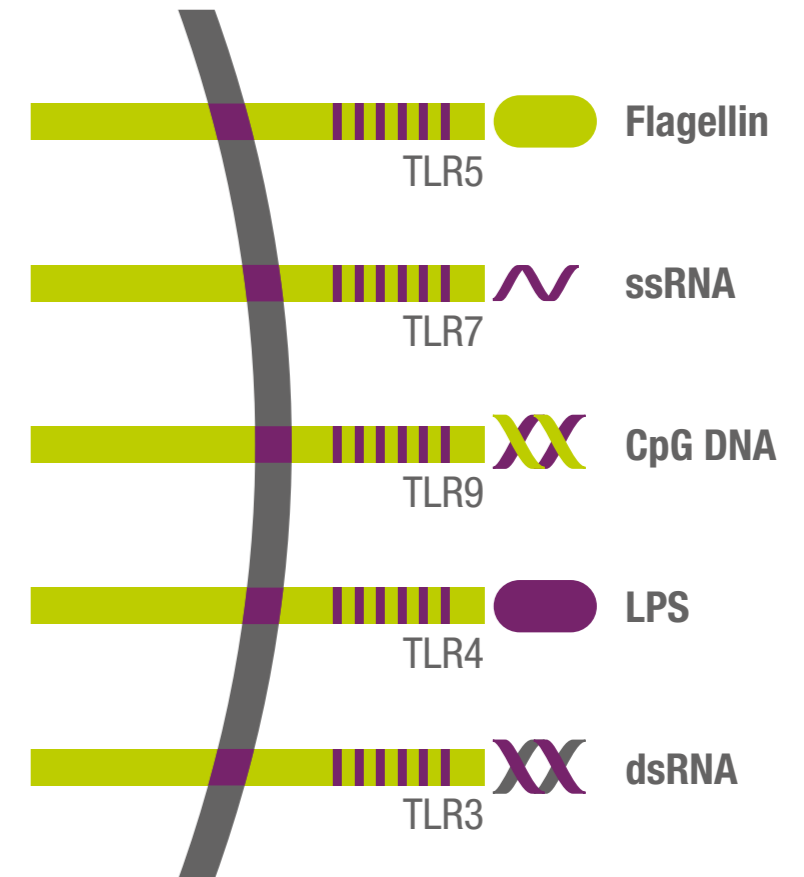
Viral vector vaccines

Some licensed influenza vaccine manufacturers have replaced egg-based with cell-based virus production<sup>13</sup>



New adjuvants are being used to tailor immune responses to influenza candidate vaccines e.g. Toll-like receptor (TLR) ligands<sup>11</sup>

Examples of TLRs and their respective ligands



Future influenza vaccines: seven key areas should be addressed:<sup>4,11,14</sup>

1

Selection of the vaccine seed virus

2

Use of cultured cells for virus preparation

3

Increasing the neuraminidase content of vaccines

4

Targeting T-cell immunity

5

Targeting different populations

6

Development of novel classes of adjuvants

7

Development of universal vaccines

Guest editor **Behazine Combadière** comments:

**“We have begun to address many of the challenges on our roadmap towards providing better protection against influenza viruses”**

For further information on this topic see the February 2022 edition of InFluNews which can be found on the [new GII LinkedIn page](#)

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**References.** 1. Carter C, *et al.* Safety and immunogenicity of investigational seasonal influenza hemagglutinin DNA vaccine followed by trivalent inactivated vaccine administered intradermally or intramuscularly in healthy adults: An open-label randomized phase 1 clinical trial. *PLoS One* 2019;14(9):e0222178. doi: 10.1371/journal.pone.0222178. 2. ClinicalTrials.gov. Study NCT03186781. Available at: <https://clinicaltrials.gov/ct2/show/study/NCT03186781?term=DNA+vaccine&cond=influenza&draw=2&rank=4>. 3. Houser KV, *et al.* Safety and immunogenicity of a ferritin nanoparticle H2 influenza vaccine in healthy adults: a phase 1 trial. *Nat Med* 2022;28:383–391. doi: 10.1038/s41591-021-01660-8. 4. McIlwain DR, *et al.* Human influenza virus challenge identifies cellular correlates of protection for oral vaccination. *Cell Host Microbe* 2021;29(12):1828–1837.e5. doi: 10.1016/j.chom.2021.10.009. 5. Moderna. December 10 2021. Moderna announces positive interim Phase I data for mRNA flu vaccine and provides program update. Available at: <https://investors.modernatx.com/news/news-details/2021/Moderna-Announces-Positive-Interim-Phase-1-Data-for-mRNA-Flu-Vaccine-and-Provides-Program-Update/default.aspx>. 6. Byrne J. Moderna says data from Phase 2 study of mRNA flu vaccine will be key. Available at: <https://www.biopharma-reporter.com/Article/2021/12/13/Moderna-says-data-from-Phase-2-study-of-mRNA-flu-vaccine-will-be-key>. 7. Sanofi Press Release June 22, 2021. Sanofi and Translate Bio initiate Phase 1 clinical trial of mRNA influenza vaccine. Available at: <https://www.sanofi.com/en/media-room/press-releases/2021/2021-06-22-07-00-00-2250633>. 8. Sanofi Press Release September 28, 2021. Sanofi announces positive Phase 1/2 study interim results for its first mRNA-based vaccine candidate. Available at: <https://www.sanofi.com/en/media-room/press-releases/2021/2021-09-28-08-00-00-2304069>. 9. Pfizer clinical trials 2022. A Study to Evaluate the Safety, Tolerability, and Immunogenicity of a Modified RNA Vaccine Against Influenza. Available at: <https://www.pfizerclinicaltrials.com/find-a-trial/nct05052697>. 10. CureVac.com. Pipeline 2022. Available at: <https://www.curevac.com/en/pipeline/>. 11. Yamayoshi S, Kawaoka Y. Current and future influenza vaccines. *Nat Med* 2019;25(2):212–220. doi: 10.1038/s41591-018-0340-z. 12. Vu MN, *et al.* Current and future nanoparticle vaccines for COVID-19. *EBioMedicine* 2021;74:103699. doi: 10.1016/j.ebiom.2021.103699. 13. Rockman S, *et al.* New Technologies for Influenza Vaccines. *Microorganisms* 2020;8(11):1745. doi: 10.3390/microorganisms8111745. 14. Moore KA, *et al.* A Research and Development (R&D) roadmap for influenza vaccines: Looking toward the future. *Vaccine* 2021;39(45):6573–6584. doi: 10.1016/j.vaccine.2021.08.010.