



Covid-19 Vaccines

Since 2013 RNA vaccines for laboratory studies can be produced in 7 days starting from genomic sequence (March 31st–April 7, 2013)

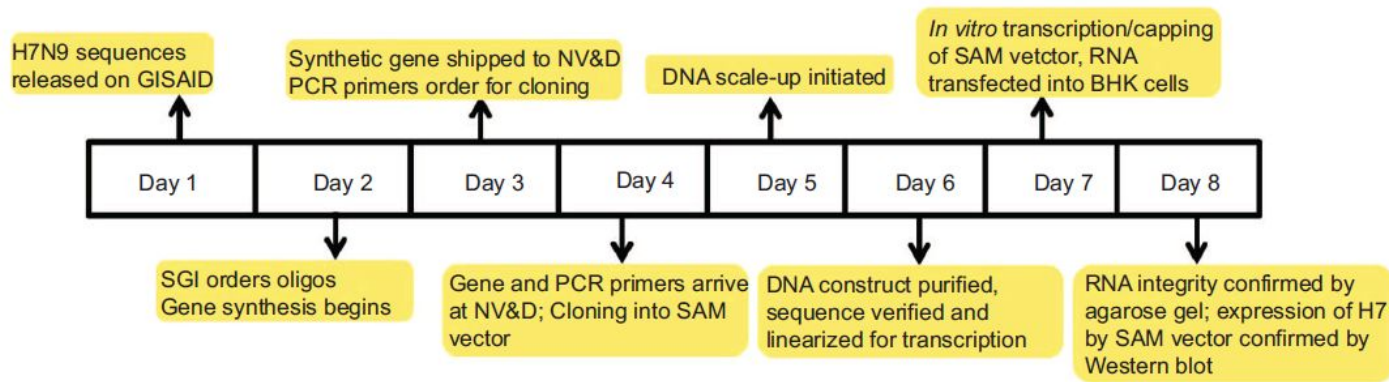


Figure 2 Timeline from electronic gene sequence posting to production of RNA prior to formulation with the LNP delivery system. GISAID, Global Initiative for Sharing All Influenza Data; PCR, polymerase chain reaction.

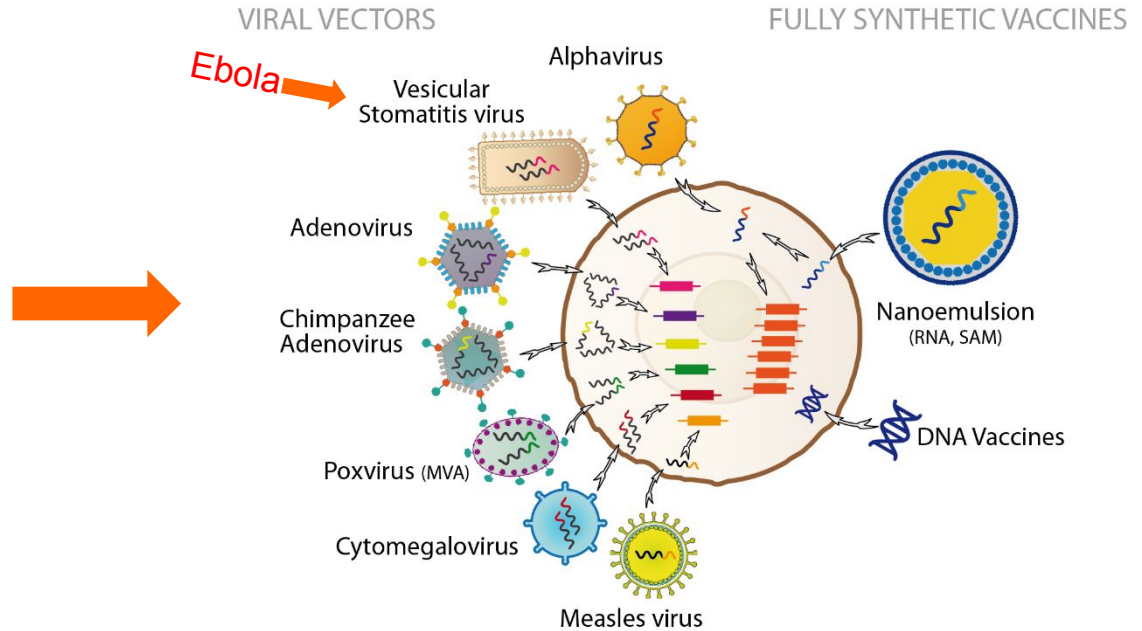
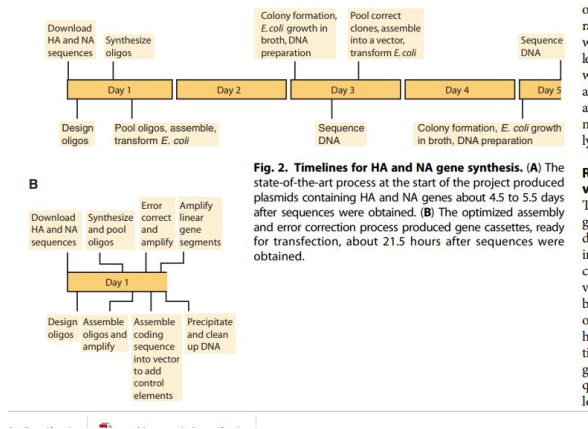
Rapidly produced SAM[®] vaccine against H7N9 influenza is immunogenic in mice

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Synthetic gene can be produced and spliced into a vaccine viral vector in 5 days

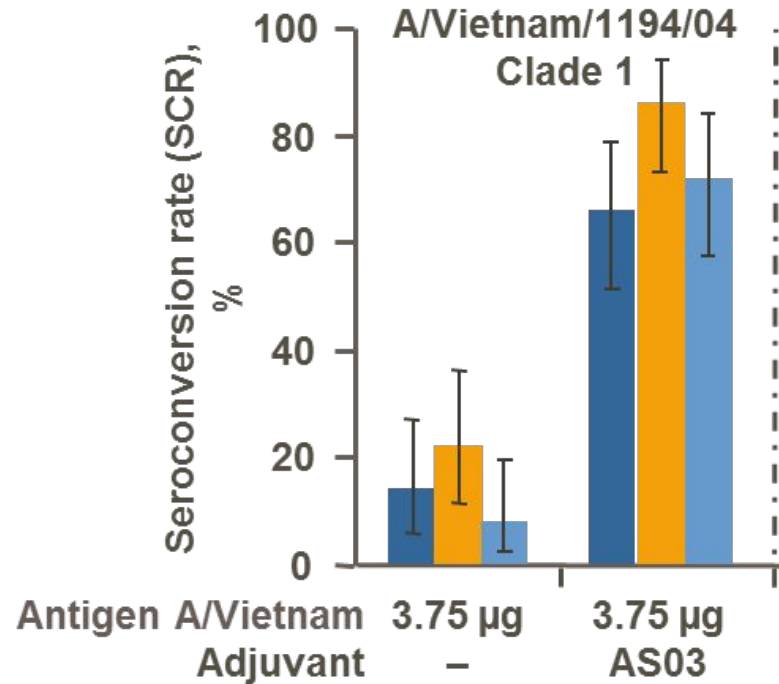


Synthetic Generation of Influenza Vaccine Viruses for Rapid Response to Pandemics

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Synthetic genes can be used to generate cell lines producing spike proteins in 2-3 weeks

Protein-based vaccines need adjuvants



Advantages of adjuvants: - Increased immune response, increased breadth, dose sparing (AS03, clinical data)

Types of Vaccines and Immunotherapy

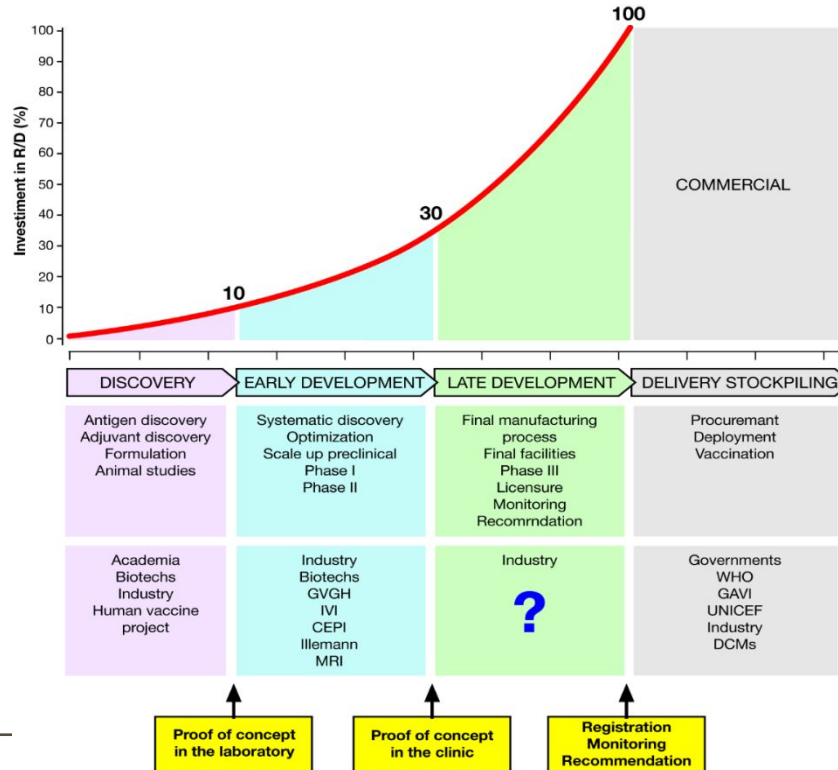


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- **RNA vaccines**, These can be developed very quickly (in 2013 we had a vaccine against H7N9 to immunize mice in one week). The platform is not yet mature, there is no vaccine approved with this technology, safety still in question. However, depending on the risk/benefit could be the fastest approach. Indeed an RNA vaccine was the first one to get to phase I clinical trial.
 - **Viral vectors** (Adeno, ChAd, measles, VSV, Pox, CMV....) The platform is more mature than RNA, it is easy to splice a synthetic gene into a vector. One product (Ebola) already licensed, others in phase III, safety is reasonable. some manufacturing capacity is available. This can also be fast.
 - **Traditional protein-based vaccines** Recombinant spike protein to expressed in mammalian cells, baculovirus or plant cells +/- adjuvants. The spike protein will probably be engineered to stabilize the prefusion form. I am sure this technology is going to work. Initially it will require more time to get to phase I, but given the experience we have in developing and manufacturing protein based vaccines, this is probably the technology we need to count on, if we need very large number of vaccine doses. Very likely any protein based vaccine will require an adjuvant to improve the immunogenicity and for dose sparing.

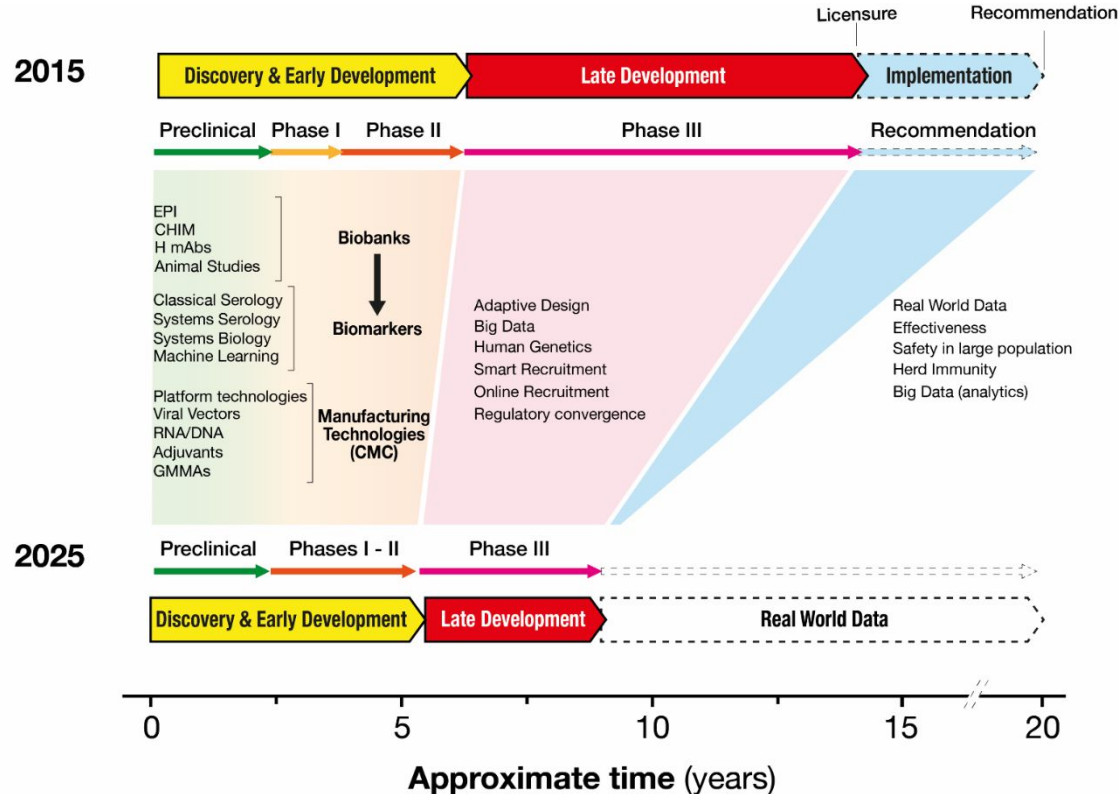
Human monoclonal antibodies starting from PBMCs from convalescent people. These can be extremely important for therapy and prevention. In the case of Ebola they have been the fastest therapeutic tool developed.

Vaccine Development

Early phase is only 10% of work



Transforming vaccine development to make vaccines available faster



COVID-19 needs a Manhattan Project



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Governments do not make vaccines, companies do
David Sinclair, Lifespan, Atria International
