How to Make a Coronavirus Vaccine

An update on the essay: “Coronavirus-19/COVID-19, reflections by an immunologist”,

This update should be read in conjunction with the above essay, especially the diagram explaining how Coronavirus-19 infects cells. The diagram below is a flow chart clearly explaining the different methods that are being applied to development of a viral vaccine with particular relevance to Coronaviruses. It was produced by Charles Schmidt for the June 2020 edition of Scientific American under the title: “The Vaccine Quest: Only Genetic Engineering Can Create a Protective Serum in Months Rather Than Years”. Note that the term “Protective Serum” in the title is incorrect as a vaccine is not a serum. The remainder of the article is correct at the time of writing.

The upper left 3 lozenges describe the 3 conventional methods of producing vaccines, such as measles, influenza, polio, etc., i.e. from left to right, (1) by weakening the virus so that it no longer replicates inside a human cell (attenuation); (2) by killing the virus; or (3) by isolating part of the virus such as a spike protein. The upper right 3 lozenges describe modern recombinant DNA or RNA technologies, viz. (1) isolate a gene encoding a viral protein or part of a protein used by the virus to infect a cell (for Coronaviruses the genome is RNA, so the gene is copied to DNA). The viral DNA gene is then inserted into a plasmid (circular bacterial DNA). The plasmid is then inserted into a bacterium which will make the viral protein. The bacteria are then grown in very large quantities and the viral protein isolated for use as a vaccine. Alternatively, the plasmid DNA can be injected directly into muscle or skin which will then make the viral protein to initiate an immune response. (2) The second method is to incorporate part of the viral RNA into lipid (fatty acid) droplets called liposomes. These can be injected into muscle or skin, in the same way as plasmid DNA, which will make the viral protein encoded by the RNA. (3) The third method, currently being used by the Oxford University Vaccine Group and the Jenner Institute for Vaccine Research, is to incorporate the gene for the virus spike protein into a harmless, weakened virus (the carrier), such as adenovirus, that cannot replicate effectively. The Oxford vaccine has now reached a Phase II clinical trial involving 510 volunteers and, if successful, will progress to a Phase III trial. Some organisations are using other weakened virus carriers. The Imperial College, London Group is developing an RNA vaccine for injection into muscle (upper right lozenge 2 in the flow chart), currently in a Phase I clinical trial. For an explanation of the different types of clinical trials (Phase I, II & III) see my previous essay on the subject, referred to above. There are nearly 100 research groups, institutions and biotechnology companies around the world currently at various stages of developing Coronavirus-19 vaccines. Bearing in mind that many vaccines against other viruses and bacteria have failed to reach or pass Phase III trials and be granted approval by the relevant health regulatory authority for each country, such as NICE in the UK and the Food & Drug Administration in the USA, many of these will probably fail as the historical success rate has been in the region of 10 – 16%. However, the use of recombinant technology to produce vaccines is relatively new and holds great promise for success as so many organisations are using these various approaches to solve the problem of developing an effective vaccine.

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How to Develop a Virus Vaccine

A vaccine exposes the body to an altered, safe version of a disease-causing virus, prompting the immune system to produce antibodies—proteins that can stop the real pathogen from infecting cells. The immune system then remembers how to fight the invader. Scientists can use different methods to create a chemical vaccine formulation, which they then test for safety and efficacy.