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Perspective

Use of Messenger RNA as a Medium for Vaccination

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DESCRIPTION

Vaccines aid in infection prevention by preparing the body to fight foreign invaders (such as bacteria, viruses, or other pathogens). All vaccines introduce a harmless piece of a specific bacteria or virus into the body, eliciting an immune response. The majority of vaccines contain weakened or dead bacteria or viruses. Scientists have developed a new type of vaccine that employs a molecule known as messenger RNA (mRNA) rather than a component of a bacteria or virus. Messenger RNA is a type of RNA that is required for protein synthesis. When cells finish producing a protein, they rapidly degrade the mRNA. Vaccine mRNA does not enter the nucleus and has no effect on DNA. mRNA vaccines work by delivering a piece of mRNA that corresponds to a viral protein, typically a small fragment of a protein found on the virus's outer membrane. (People who receive an mRNA vaccine are not exposed to the virus and cannot be infected by the vaccine.) Cells can produce the viral protein by using this mRNA. The immune system recognizes that the protein is foreign and produces specialized proteins known as antibodies as part of a normal immune response. Once produced, antibodies remain in the body even after the pathogen has been eliminated, allowing the immune system to respond quickly if exposed again. When a person is exposed to a virus after receiving mRNA vaccination for it, antibodies recognize it quickly, attach to it, and mark it for destruction before it causes serious illness.

mRNA is the intermediate step between protein-encoding DNA translation and protein production by cytoplasmic ribosomes. As vaccines, two types of RNA are currently being researched: non-replicating mRNA and virally derived, self-amplifying RNA. Traditional mRNA-based vaccines encode the antigen of interest and include 5′ and 3′ untranslated regions (UTRs), whereas self-amplifying RNAs encode not only the antigen but also the viral replication machinery, allowing intracellular RNA amplification and abundant protein expression. Several mRNA vaccine platforms have been developed in recent years and validated in immunogenicity and efficacy studies. RNA sequence engineering has made synthetic mRNA more translatable than ever before. Highly efficient and non-toxic RNA carriers have been developed, allowing for prolonged antigen expression *in vivo* in some cases. Some vaccine formulations contain novel adjuvants, while others elicit potent responses even when no known adjuvants are present. The most effective way to contain and prevent epidemics is to develop prophylactic or therapeutic vaccines against infectious pathogens. Conventional vaccine approaches, on the other hand, have largely failed to produce effective vaccines against difficult viruses that cause chronic or recurring infections, such as HIV-1, herpes simplex virus, and Respiratory Syncytial Virus (RSV). Furthermore, the slow pace of commercial vaccine development and approval is insufficient to address the rapid emergence of acute viral diseases. Against infectious pathogens, two types of RNA vaccines have been used: self-amplifying or replicating RNA vaccines and non-replicating mRNA vaccines. Non-replicating mRNA vaccines are further distinguished by their mode of administration, which can be either the *ex vivo* loading of DCs or direct *in vivo* injection into a variety of anatomical sites.

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