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Why shrimp cannot be vaccinated

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Shrimp lack appropriate cells, pathways to respond to specific pathogens and the long-term 'memory' to deal with recurring infections

Although shrimp can benefit from treatments that stimulate their innate immune responses, they cannot be vaccinated against specific pathogens.

Scientific literature on shrimp has often adopted terms and approaches from mammalian immunology, but not always in a correct way. Such is the case in the use of the term “vaccination” in crustaceans. The principle of vaccination is based on two key elements of the immune system: specificity and memory. These two properties are not recognized in the immune systems of shrimp and other invertebrates.

Immune responses

Any immune response involves, firstly, recognition of the pathogen or other foreign material and, secondly, the mounting of a reaction against it to eliminate it. Thus, the host needs appropriate cells, molecules, and pathways to achieve long-term “memory” to deal with subsequent infection.

Broadly speaking, immune responses fall into two categories: innate (or nonadaptive) and adaptive. Vaccination targets the adaptive, memory-type component.

Humans and animals have very effective physicochemical barriers as a first line of defense, such as skin, scales or cuticle, and mucus. Once these barriers are breached, potential invaders are then exposed to a range of cellular and humoral defense reactions. These include blood clotting and wound healing, phagocytosis, encapsulation, and antimicrobial factors.

These barriers and reactions are components of innate immune response that act at the earliest stage of infection. At later stages, adaptive immune responses are generated based mainly on the production of lymphocytes and release of antibodies. Memory cells (lymphocytes) allow the adaptive immune system to mount a stronger, quicker, and highly specific response upon a second encounter with an antigen.

The important difference between the immune response types is that adaptive responses are highly specific for a particular pathogen. Moreover, adaptive responses improve with each successive encounter with the same pathogen because the adaptive immune system “remembers” the infectious agent. The two key features of adaptive immune responses are thus specificity and memory, factors upon which vaccines work.

Nonspecific immune responses

Invertebrates comprise approximately 95 percent of all animal species. Despite the success of invertebrates in terms of evolution, they lack the cells and pathways used by jawed vertebrates to mount adaptive immune responses. Invertebrates share with vertebrates many similar cells and molecules in their nonspecific immune systems, but invertebrates did not evolve lymphocytes or the ability to generate specific antibodies.

Immunostimulants

Vaccination is a term that has been coined to define a product that elicits a specific reaction. It should be strictly applied only when the purpose is to confer long-lasting protection through immunological memory.

These “vaccination” protocols often include the use of adjuvants such as killed mycobacterial cells, aluminum salts, or mineral oil. Adjuvants provide a “depot” effect and enhance antibody response. These usually act on one or more nonspecific innate components of the immune system, such as cytokines and antigen presentation, acting as immunostimulants to maximize specific responses.

Therefore immunostimulation is a better term than vaccination for applications regarding the challenge of crustaceans with pathogens or antigens.

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