Chitin, a structural molecule associated with allergy response, is identified in vertebrates

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Scientists at Benaroya Research Institute at Virginia Mason (BRI) have made an unexpected discovery that overturns a longstanding belief in the biological sciences. Research, led by Chris Amemiya, PhD, a member at BRI, and primarily conducted by Joyce Tang, was published online in today's issue of *Current Biology*. The research demonstrates that chitin, a molecule that was previously thought to be absent in vertebrates and that has been shown to trigger an allergy/immune reaction in mammals, is endogenously produced in fishes and amphibians.

"Based on our observations, it is clear that vertebrates probably use chitin in very different ways than invertebrates or fungi," noted Dr. Amemiya. "Our hope is that by studying the biological roles of chitin in vertebrates, we will uncover broad generalizable principles, thereby allowing us to extend its use in biomedical and practical applications."

Chitin is primarily known as a molecule that forms hard structures like fungal cell walls and the exoskeletons of invertebrates such as insects and crustaceans. It is a polymer made up of many repeating units of a sugar called N-acetylglucosamine, is naturally produced in many organisms, and forms a strong and pliable material that is made even stronger when complexed with other materials (such as proteins and minerals) to form the protective outer shells of insects and crustaceans.

The general belief that vertebrates lack chitin was largely based on the presumed absence within vertebrate genomes of a gene called chitin synthase, whose activity is necessary to produce chitin. However, upon

closer examination of many vertebrate genomes, the Amemiya laboratory identified fish and amphibian genes that strongly resembled chitin synthase genes found in insects. Using multiple experimental approaches, including genomics, developmental biology, and chemical purification and analysis, the authors have demonstrated that chitin synthase genes are active in fishes and an amphibian and that they endogenously generate chitin.

"These findings seemingly flip the previously held assumptions about vertebrates and chitin on their head," noted Steven Ziegler, PhD, Director of the Immunology Research Program at BRI. Prior research from Dr. Ziegler and Richard Locksley, MD (UCSF), demonstrated that chitin produces an allergic reaction in mice. Taken together with Dr. Amemiya's findings identifying chitin in fishes and amphibians, this exposes a paradox with regard to the role of chitin in vertebrates and the evolution of chitin synthase genes. Chitin is expressed in fishes and amphibians, however, chitin synthase genes are no longer maintained in the genomes of mammals and chitin exposure induces an immune response.

Chitin's current and potential uses across agriculture, industry and medicine are quite broad. Chitin, which naturally induces anti-fungal defense responses in plants, has been used in agriculture to protect against fungal infections and as a fertilizer. In addition, due to the malleable nature of the chitin polymer, it has also been leveraged in biomedical applications including surgical sutures, wound healing approaches, drug delivery vessels and bioscaffolds for tissue engineering. Chitin has also been shown recently to be an excellent material for biodegradable plastics.

More information: *Current Biology*, www.sciencedirect.com/science/… ii/S0960982215000901

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