

## FOOD ALLERGY ACTIVATION IN HUMANS

Calvin Foss

*Physics, Frank R. Seaver College of Science and Engineering, Loyola Marymount University*

Dr. Dave Berube

*Research Mentor, Clinical Associate Professor of Physics, Frank R. Seaver College of Science and Engineering, Loyola Marymount University*

In this proposal, I am requesting funding to conduct research into the prevention of food allergy activation. Current research in the field of allergy and clinical immunology details the biochemical processes, prevalence, and mediation of food allergies in humans. Specifically, the most common allergies of cow's milk (henceforth milk), hen's eggs (henceforth eggs), peanuts, tree nuts, fish, shellfish, wheat, and soy have been studied to determine how they interact in the body, how many people they affect, and how they can be controlled in the population.<sup>1,2,3</sup> The National Institute of Allergy and Infectious Diseases sponsored a team of researchers that defined a food allergy to be "an adverse health effect arising from a specific immune response that occurs reproducibly on exposure to a given food,"<sup>2</sup> and this definition will be used in the course of this research. If food allergies are common and can have life threatening consequences, what can be done to prevent them? The biochemical pathways of allergic responses are fairly well known, and yet, the best prevention of food allergies up until now is strict avoidance.<sup>1,2,3</sup> Specifically, this research proposal aims to determine if the allergen molecules in the foods or the receptor pathways in the body could be modified to prevent food allergy reactions.

### I. INTRODUCTION

The prevalence of food allergies poses a difficult challenge for researchers to ascertain as different studies in the United States have produced significantly different results. Current estimates from Sicherer and Sampson place the proportion of the population that suffers from food allergies at around 5% for adults and 8% for children.<sup>3</sup> That number is predicted to rise due to a myriad of factors surrounding lifestyle issues with health including obesity and increased hygiene.<sup>2</sup> The consequences of these food allergies are very real and unfortunate; Sicherer and Sampson extrapolated data from US studies and found over 100,000 emergency

department visits each year were related to food allergies.<sup>1</sup> Additionally, the most extreme cases of allergies to milk, eggs, peanuts, tree nuts, fish, shellfish, wheat and soy involve an anaphylactic response of multiple organs reacting negatively and rapidly which "can include cardiovascular collapse."<sup>1</sup>

My interest in this topic stems from my own intolerance to lactose present in milk and its derivatives and my field of study in physics and biophysics. The two conditions of being allergic and intolerant are very different, however, and the focus of this proposal is food allergies.

The prevalence and danger of food allergies in the US clearly poses a problem: what is being done to manage and prevent this health issue? As mentioned, the current strategy for preventing allergies in the population is avoiding allergens altogether. This research proposal will investigate whether a more permanent solution of deactivating allergens or allergic response pathways might exist.

## II. BACKGROUND

In order to determine a food allergy before experiencing an actual allergic response, doctors in the field of immunology will use the Skin Prick Test where exposure to small amounts of possible allergens can inform with a high degree of certainty whether an individual is allergic to a certain food or other allergen.<sup>1</sup> In accordance with diagnoses, laws in place in the US require foods to be labelled if they contain possible allergens, especially ones that can cause anaphylaxis.<sup>1</sup> With proper labelling and warnings as well as early diagnosis of an allergy, many possible instances of allergic responses can be avoided. Furthermore, in the unfortunate event that someone ingests a food and undergoes an anaphylactic response, the use of epinephrine can stop the response from becoming deadly.<sup>1</sup> Therefore, the prevailing methods for controlling allergies are correct diagnosis, avoidance, and treatment of symptoms.

Even with the success of these steps, a more comprehensive way to combat allergic responses to foods would benefit hundreds of thousands of people, cutting down on health care costs and making more food enjoyable to a large proportion of the population. In order to stop the possibility of allergic responses altogether, this research will look into the processes that make up the body's reaction to

specific foods. Specifically, the most common allergies occur when the body produces the Immunoglobulin E (IgE) antibody in reaction to a harmless antigen.<sup>4</sup> These responses are deemed IgE-mediated, and they have effects including gastrointestinal hypersensitivity, acute angioedema, allergic rhinitis, acute bronchospasm, and anaphylaxis.<sup>4</sup> In lay terms, the reactions associated with an allergic response such as trouble breathing and swelling of the skin are IgE-mediated responses. Anaphylaxis is the body's most severe response that is made up of many different symptoms including difficulty breathing and impaired cognition that can lead to death without prompt administration of epinephrine. In order to prevent the possibility of such allergic responses, current research in the field of immunology focuses on introduction of the allergens to mothers before and after pregnancy as well as to the newborn within the first year to desensitize infants to the most common allergies and prevent them from growing up with a food allergy from a very young age.<sup>1</sup>

Sicherer and Sampson discuss how research from 2010 and on is also looking into novel ways of approaching prevention through immunotherapy.<sup>3</sup> If the body's immune system is erroneously responding to a food antigen, the system might be susceptible to desensitization with prolonged exposure to low levels of the antigen. Similar to that approach, this research will analyze the composition of the IgE antibodies, the processes through which they are activated, and whether these processes can be prevented without harm to individuals. Additionally, the research will further investigate the milk, egg, peanut, tree nut, fish, and shellfish proteins that trigger the IgE-mediated responses. With a better understanding of the composition and function

of these proteins that are mistaken for allergens, this research proposal asks can the proteins or the IgE antibodies be denatured or altered in such a way that they will not trigger the immune response?

### III. METHODS

In order to accomplish the research goals, this research proposal will require further information on the two factors of composition and function of IgE and food allergens as presented in the literature from the field of immunology. In order to determine whether the two factors can be altered, the research will only perform experiments with isolated proteins and antibodies and speculate on effects on the human body. Preliminary research suggests that the exposure of denatured milk and egg proteins such as in baked milk or baked egg products to individuals suffering from those allergies might develop a tolerance to those allergens.<sup>3</sup> This result is an example of immunotherapy. Further research into immunotherapy reveals that oral, sublingual, and epicutaneous immunotherapy involve exposure to allergens through consumption, placing of the substance under the tongue, and injecting under the skin.<sup>5</sup> These methods have varied success and are limited to working with children from around 4 to 11 years of age.

In order to obtain a more general solution to the issue of allergic reactions, more background information on the issue provides a basis from which to devise methods for successful prevention. For example, the discovery of parallels between plant-based food allergies and pathogenesis-related proteins may reveal the characteristics of the allergens in the foods.<sup>6</sup> Knowledge of these characteristics may be exploited in order to stop the allergens from

causing the allergic response. Research into fish and shellfish has revealed the preponderance of cross reactivity of patients to various types of fish and shellfish with similar key proteins.<sup>7</sup> This fact implies that preventing the patients' immune systems from reacting to one allergen would likely prevent reaction to multiple various sources. Using these sources and more, the research will investigate how these proteins can be denatured through normal methods including heating, cooling, and exposing to alcohol, acids and bases, and heavy metals. In order to address the immune system's IgE-mediated response, similar techniques may be implemented to prevent allergic reactions to the food allergens.

### IV. EXPECTED RESULTS

The end product of this research will be a research paper that can be submitted to academic journals for review and confirmation that will detail at least one method for altering the IgE molecule or proteins associated with food allergens such that allergic individuals may safely consume the food to which they are allergic. Due to the number of common food allergies, the research will first attempt to alter the IgE molecular pathways so that any individual who suffers from an IgE-mediated food allergy would no longer have unnecessary allergic reactions. If that alteration is not feasible, the research will then attempt to denature the proteins in the most common of the food allergens so that the food could be treated and distributed for allergic individuals to consume without worry of having an allergic reaction.

### V. CONCLUSION

This research proposal seeks to find a solution to the common problem of food

allergies that, as of yet, has not been adequately addressed. The research will use the newest research available in the field of immunology to create a solid background in allergy prevention. Using this background, the IgE molecule and allergen proteins will be modified in various ways to determine what can prevent immune response. There could be no viable method for preventing allergic reactions altogether, but this research would not be able to exhaust every possibility for alteration and thus a negative result would not rule out that a viable method exists. However, this research proposal hopes to conduct research that will lead to formulation of solutions to a problem that affects millions of people around the world.

#### REFERENCES

1. H. A. Sampson and S. H. Sicherer, "Food allergy," *J. Allergy Clin. Immun.* 125(2), 116-125 (2010).
2. J. A. Boyce, A. Assa'ad, A. W. Burks, S. M. Jones, H. A. Sampson, R. A. Wood, M. Plaut, S. F. Cooper, and M. J. Fenton et al., "Guidelines for the Diagnosis and Management of Food Allergy in the United States: Summary of the NIAID-Sponsored Expert Panel Report," *J. Allergy Clin. Immun.* 126(6), 1105-1118 (2010).
3. H. A. Sampson and S. H. Sicherer, "Food allergy: Epidemiology, pathogenesis, diagnosis, and treatment," *J. Allergy Clin. Immun.* 133(2), 291-307 (2014).
4. D. D. Metcalfe, H. A. Sampson, R. A. Simon, *Food Allergy : Adverse Reactions to Foods and Food Additives*, 4th ed. (Blackwell P., Malden, MA, 2008).
5. S. M. Jones and B. A. Wesley, "Food Allergy," *New Eng. Jour. of Med.* 377(12), 1168-1176 (2017).
6. H. Breiteneder and C. Ebner, "Molecular and biochemical classification of plant-derived food allergens," *J. Allergy Clin. Immun.* 106(1), 27-36 (2000).
7. L. G. Wild and S. B. Lehrer, "Fish and shellfish allergy," *Curr. Allergy Asthma Rep.* 5, 74-79 (2005).

#### BUDGET

Foreseen costs for this research are minimal. The work does not require being in a particular location and could be executed in a laboratory setting at LMU with minimal resources. The timeline for completing the work is tough to estimate as the nature of the research is into a problem with no singular answer. There could be many different ways to deactivate the IgE-mediated process or the proteins in the most common food allergies, and testing of any method found through the research would be difficult due to the lack of human subjects with which to confirm the eventual solution. Therefore, a likely timeline for the research would be at least a month of working on the problem on its own, and possibly multiple months in the case of working concurrently with classes during the semester at LMU. As for actual cost of the materials, obtaining the IgE molecule and common food allergens are inexpensive, and the methods for deactivating the molecules are not particularly expensive.