the parents. Investigators conducted interval testing of peripheral blood eosinophil count, skin prick tests, and IgE testing. Infants’ microbiota were assessed through collection of fecal samples at 1 and 12 months of life. Polymerase chain reaction fragments from infant stool separated by DGGE (denaturing gradient gel electrophoresis) provided relative assessment of main bacterial strains and were used in assessing variety and richness in microbial genetic diversity. Cultures were used to identify bacteria, fungi, and yeast present in infant stool.

RESULTS. In looking at trends associated with diversity of microbiota as measured by band richness on DGGE, investigators found that diversity of intestinal flora was inversely associated with allergic rhinitis \( (P = .007) \), allergic sensitization (serum specific IgE, \( P = .003 \), and skin prick test, \( P = .17 \) ), and peripheral blood eosinophil count \( (P = .34) \). Band richness at 1 month was not predictive of band richness at 12 months, but band richness at each point in time independently was associated with these measures of specified atopy. No significant association was found between band richness and development of asthma or atopic dermatitis. Particular bands seen on DGGE and specific microbiota isolated by culture were not significantly associated with clinical or laboratory evidence of atopic disease. Interestingly, it was noted that in children with culture positive for staphylococci, there was reduced band richness \( (14.8 \text{ vs } 13.8) \) \( (P = .06) \). Additionally, risk for development of allergic sensitization was increased in infants with cultures positive for staphylococci at 1 month of age but not at 12 months.

CONCLUSIONS. The authors concluded that increased bacterial diversity in infants’ intestinal flora reduced risk of allergic sensitization, allergic rhinitis, and peripheral blood eosinophilia. Although a particular bacterial strain was not found to be protective, results suggest that certain pathogenic bacteria such as *Staphylococcus* sp may increase risk for allergic disease, possibly through reduction in diversity of intestinal flora.

REVIEWER COMMENTS. This study supports the association between decreased diversity of intestinal flora and development of allergic phenotype, specifically allergic sensitization, eosinophilia, and allergic rhinitis. It is interesting, however, that bacterial diversity in the intestinal flora was not associated with the development of asthma and atopic dermatitis. It might have been useful to look at the impact of intestinal microbiota on the development of food allergies. Additionally, the authors mainly focus on outcomes of the diversity of intestinal microbiota, without addressing mechanism or contributing factors. Future studies in this area may include development of food allergy as an outcome and address risk factors and potential interventions that promote or limit the diversity of infants’ intestinal microbiota and subsequent development of atopy.


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The Antibacterial Lectin RegIII-Gamma Promotes the Spatial Segregation of Microbiota and Host in the Intestine

PURPOSE OF THE STUDY. The mammalian intestine is home to \( ~100 \text{ trillion} \) bacteria that perform important metabolic functions for their hosts. The proximity of vast numbers of bacteria to host intestinal tissues raises the question of how symbiotic host-bacterial relationships are maintained without eliciting potentially harmful immune responses.

METHODS. The authors developed a strain of mice that did not express the RegIIIy protein (“RegIIIy\(-/-\)” mice). The authors then tested the effects of the gene deletion on the separation between the small-bowel mucosa and luminal bacterial, and also T-cell, inflammation in the intestinal wall.

RESULTS. RegIIIy, a secreted antibacterial lectin, was found to be essential for maintaining a \( \sim 50-\mu m \) zone that physically separates the microbiota from the small-intestinal epithelial surface. Interestingly, colonic mucosa expressed relatively little RegIIIy, and gene deletion did not affect relationships with bacteria in the colon. Loss of host-bacterial segregation in RegIIIy\(-/-\) mice was coupled to increased bacterial colonization of the small-intestinal epithelial surface and enhanced activation of intestinal adaptive immune responses by the microbiota.

CONCLUSIONS. The authors conclude that RegIIIy is a fundamental immune mechanism that promotes host-bacterial mutualism by regulating the spatial relationships between microbiota and host in the intestine. These findings could be relevant to the pathogenesis of inflammatory bowel disease and other disorders of chronic intestinal inflammation.

REVIEWER COMMENTS. Have you ever wondered why the mucosal immune system in the intestines can tolerate the huge amounts of bacteria, along with endotoxin and other immunostimulants packed into the intestines? Even a tiny fraction of this material in the peritoneum or bloodstream would cause sepsis and/or shock. This fascinating article illustrates (literally) a mechanism by which an antibacterial lectin known as RegIIIy maintains a bacteria-free zone next to the small intestinal epithelium that forms a barrier against bacterial invasion of the epithelium and induction of inflammation. The
photomicrographs in the article are striking and clearly visualize the effects of this innate immune mechanism. Interestingly, other studies have shown that this same molecule is also expressed in the airways and has antibacterial functions in the respiratory tract. Understanding the regulation and function of RegIIIγ may lead to new insights into the pathogenesis and treatment of inflammatory and infectious diseases in both anatomic locations.

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Galectin-9 Induced by Dietary Synbiotics Is Involved in Suppression of Allergic Symptoms in Mice and Humans


PURPOSE OF THE STUDY. To investigate whether galectin-9 has a role in the mechanism of suppression of allergic skin reactions and mast cell degranulation induced by dietary synbiotics.

STUDY POPULATION. Three-week-old specific pathogen-free C3H/HeOuJ mice were studied in a cow’s milk allergy model with or without a probiotic or prebiotic. Ninety human infants with atopic dermatitis were studied in a double-blind, placebo-controlled multicenter trial in which they received a hydrolyzed formula with or without synbiotics.

METHODS. Mice were sensitized orally to whey while being fed a diet containing a specific prebiotic (9:1 mixture of short-chain galacto-oligosaccharides and long-chain fructo-oligosaccharides), a specific probiotic (Bifidobacterium breve M-16V), a combination of both, or a control diet (4 groups). Galectin-9 expression was determined by immunohistochemistry in the intestine and measured in the serum by enzyme-linked immunosorbent assay. T-cell differentiation was determined in the mesenteric lymph nodes as well as in galectin-9–exposed peripheral blood mononuclear cell cultures via expression of transcription factors T-bet, GATA-3, RORγT, and Foxp3 along with cytokine production assays. Sera from mice were studied for the capacity to suppress mast cell degranulation. Sera from the 90 human infants were evaluated for galectin-9 levels.

RESULTS. Galectin-9 expression by intestinal epithelial cells as well as serum galectin-9 levels were increased in mice and humans after dietary intervention with the symbiotic combination (pre- and probiotic together). In mice, the levels correlated with reduced acute allergic skin reaction and reduced mast cell degranulation. In addition, the dietary synbiotics resulted in enhanced Th1- and Treg-cell differentiation in lymph nodes and in peripheral blood mononuclear cell cultures exposed to galectin-9.

CONCLUSIONS. Dietary supplementation with a synbiotic (prebiotic short-chain galacto-oligosaccharides/long-chain fructo-oligosaccharides + probiotic Bifidobacterium breve M-16V) enhances serum galectin-9 levels which is associated with the prevention of expression of components of allergic responses.

REVIEWER COMMENTS. The results of this study show galectin-9, an epithelial product expressed in mucosal surfaces during inflammatory responses, is a significant component of the protective antiallergy effect of synbiotic treatment. This effect is supported by data showing modulation of Th1-and Treg-cell polarization as well as immunoglobulin E sequestration (another study has shown strong binding of galectin-9 to immunoglobulin E) resulting in the reduced mast cell degranulation observed. Galectin-9 may be an important marker for the suppression of food allergy and further studies are warranted.

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TSLP Promotes Interleukin-3-independent Basophil Haematopoiesis and Type 2 Inflammation


PURPOSE OF THE STUDY. Allergic diseases involve epithelial surfaces, and the epithelial cytokine thymic stromal lymphopoietin (TSLP) has been described as the “master switch” for allergic inflammation. The purpose of this study was to determine how TSLP contributes to allergic disease pathogenesis.

STUDY POPULATION. Most studies were performed in mice. Human studies were performed with the use of basophils from patients with eosinophilic esophagitis or from healthy controls.

METHODS. TSLP-treated mice were evaluated for changes in circulating immune cells and cytokine secretion. The effect of tissue-specific TSLP production was determined by using transgenic mice overexpressing TSLP in the lung, or an atopic dermatitis model. Bone marrow cells were cultured with either TSLP or interleukin (IL)-3, and basophil differentiation was assessed. Characterization of TSLP-induced basophils from mice or humans was performed by the use of gene expression analysis and immune phenotyping.

RESULTS. Mice injected with TSLP had increased numbers of IL-4–secreting basophils in the spleen, as well as increased plasma levels of the proallergic T-helper type 2 (TH2) cytokines IL-4, IL-5, and IL-13. Endogenous
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James E. Gern

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