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ALLERGIES AND HYPERSENSITIVITY

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Abstract
The enemy in allergic diseases is the immune system, which, instead of protecting the man from the dangerous external environment, is creating the disease. The global increase in these diseases is stated for developing countries, where urbanisation and industrialization occur rapidly, where also lifestyles change, as they are increasingly rising among potential triggers of allergic diseases. This paper highlights the pathophysiology, classification, diagnosis, and treatment of allergic and hypersensitivity reactions, and focuses on their management with preventive techniques. It also promotes the use of advances in treatment as well as efforts being directed towards prevention, stressing the need for precision medicine in the management of patients. Our research would help enhance the methods and patient care approaches while also shaping upcoming investigations into new treatments. Having a grasp of these mechanisms is crucial for healthcare professionals to minimise the consequences of allergic reactions and enhance patient outcomes.

Keywords: Hypersensitivity, Immune response, Anaphylaxis, Personalised medicine, Immunotherapy

1.0 Introduction
Allergies are abnormal immune responses caused by a component called an allergen. An abnormal immune response is usually directed against substances not recognised by the immune system as dangerous, thus turning on the inflammatory pathways in the body (Sicherer, 2022; Gamde *et al*., 2025). Hypersensitivity means exaggerated or inappropriate immune responses to antigens and usually comes in types, differentiated by mechanism and temporal profile of response (Johansson *et al*., 2023). The most common allergens include pollen, food, insect stings, and some medications; symptoms can range from mild to life-threatening (Norton *et al*., 2022).

When the allergen enters, it binds to IgE antibodies on mast cells and basophils, causing the release of histamine and other inflammatory mediators (Wang *et al*., 2023). This, in turn, precipitates common allergic symptoms such as itching, swelling, and bronchoconstriction (Stanaway *et al*., 2022). These reactions can turn grave with repeated exposure to the allergen, leading to increased severity of the clinical manifestations (Jutel *et al*., 2023).

A growing burden of allergic disease and related hypersensitivity reactions has important implications for the health of individuals, healthcare systems and public health strategies. Although research on the immune system has progressed, our understanding of how these reactions develop and their current management strategies is still limited, as well as reducing their effect on quality of life. Thus, this study aimed to elucidate

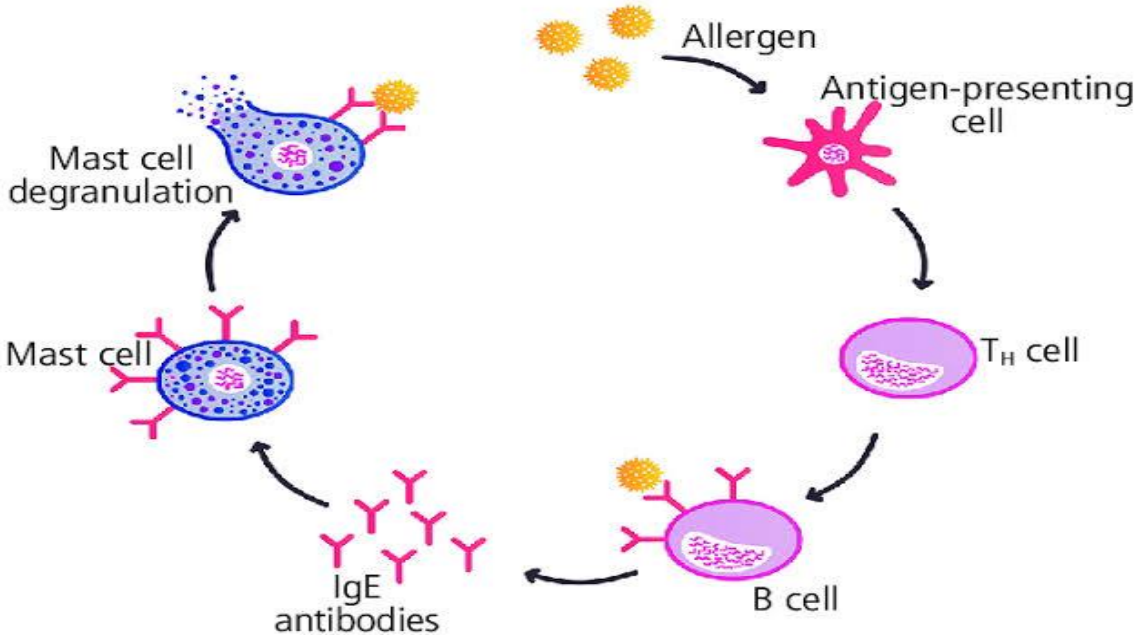
whether these pathways are involved in recognised clinically relevant types of mechanisms or consequences (pathomechanisms) of HRs, and to reveal any clinical implications. This research seeks to add to our understanding of allergies and hypersensitivity by offering an examination of the mechanisms and real-world impacts of these responses.

2.0 Literature Review

Allergies and hypersensitivity reactions represent a significant public health concern, affecting millions globally. Allergies and hypersensitivity reactions are immune responses that occur when the body reacts to typically harmless substances, known as allergens, as if they were harmful. These responses can vary in severity and manifest through a wide range of symptoms, from mild rashes and sneezing to severe anaphylaxis. The immune system's overreaction to allergens leads to tissue damage, inflammation, and a cascade of biological responses that are central to the pathophysiology of allergies and hypersensitivity (Gamde *et al*., 2024).

2.1 Mechanism of allergic reactions

An allergy is an atypically active response of the immune apparatus to a substance-allergen-that, in general terms, does not pose any danger. The general mechanism of an allergic reaction involves the following actions:



1. Sensitisation: When an allergen comes in contact with the body for the first time, sensitisation occurs. During this process, the following occur:

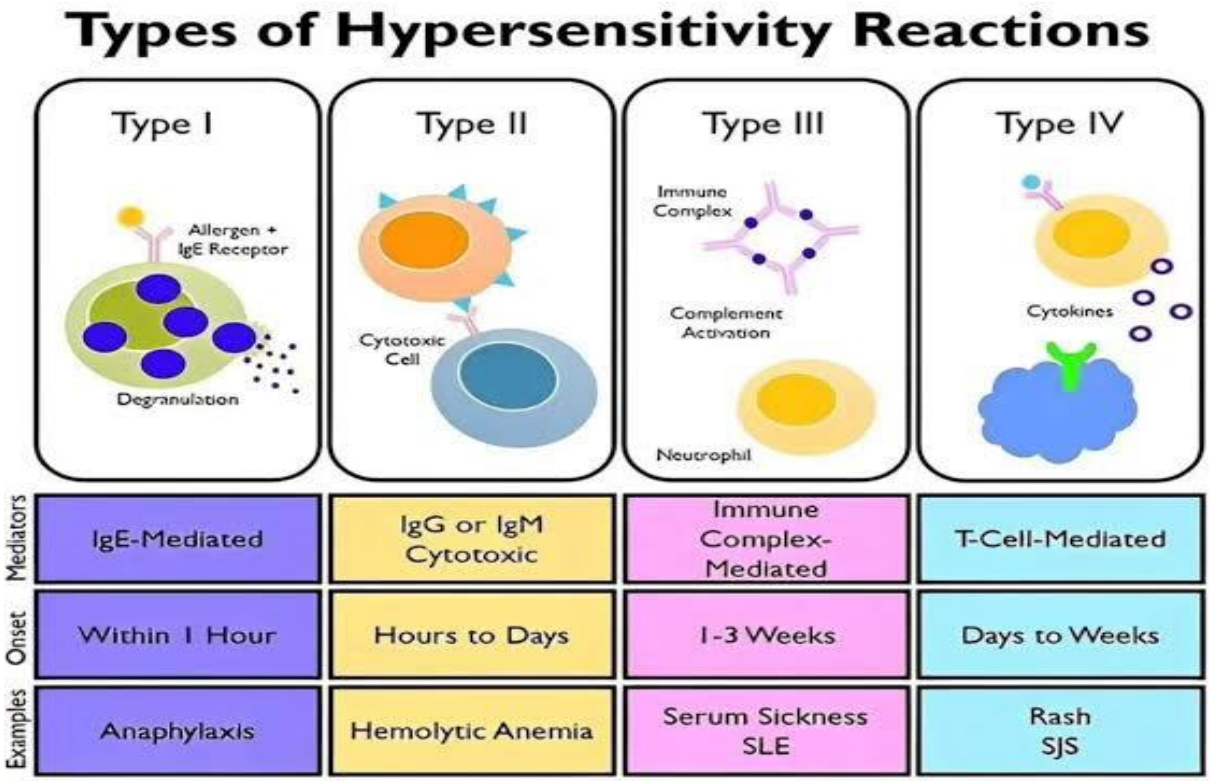
i. Allergen Recognition: The processing of the allergen by APCs, including dendritic cells, occurs, which then presents allergenic peptides to naive Th cells.

ii. T-Cell Activation: The Th cells consequently differentiate, mostly into Th2 cells secreting cytokines such as IL-4 and IL-13. These types of cytokines play an important role in the allergic response induction (Pawanker *et al*., 2011).

2. Production of IgE:

i. B Cell Activation: IL-4 leads the B cells to produce IgE antibodies to the allergen (Abel-Fernández *et al*., 2023).
ii. Mast Cell Sensitisation: IgE then binds to the high-affinity IgE receptors (FcεRI) on mast cells and basophils, thereby sensitising them against further exposure to the allergen (Jutel *et al*., 2024).
3. Re-Exposure and Allergen Cross-Linking:
i. Allergen Binding: The allergen cross-links the IgE antibodies on the surface of sensitised mast cells and basophils.
ii. Degranulation: This cross-linking initiate's mast cell degranulation, which results in the release of mediators, such as histamine, leukotrienes, and prostaglandins (Jutel *et al*., 2024).
4. Inflammatory Response: Release of these mediators results in:
i. Vasodilation and Increased Permeability: Histamine causes increased blood flow and vascular permeability, therefore leading to swelling, redness, and itching-typical signs and symptoms of allergic reactions (Hrubisko *et al*., 2021).
ii. Recruitment of Inflammatory Cells: The other mediators attract eosinophils and neutrophils to the site of exposure to the allergen and amplify the inflammatory response that was initiated (Rosenberg *et al*., 2013).
5. Clinical Manifestations:
The severity and type of allergic reaction are related to the susceptibility of the individual and the allergen. Common manifestations include:
i. Allergic Rhinitis: Sneezing, itching, and nasal congestion.
ii. Asthma: Bronchoconstriction leading to wheezing and difficulty breathing
iii. Anaphylaxis: A severe life-threatening reaction that requires immediate medical intervention (Lieberman *et al*., 2015.

2.2Types of hypersensitivity reactions
Hypersensitivity reactions can be classified according to Gell and Coombs' classification into the following four kinds:
Type I (Immediate Hypersensitivity): This type of hypersensitivity is mediated through IgE antibodies, bringing forth an immediate hypersensitivity reaction such as experienced in hay fever or anaphylaxis-based reactions, as stated by Schwartz *et al*. 2023.
Type II (Cytotoxic Hypersensitivity): IgG and IgM antibodies bind to host cells, causing their lysis, as in the case of hemolytic anaemia (Jackson *et al*., 2022).
Type III (Immune Complex-Mediated Hypersensitivity): Immune complexes deposit in tissues and induce diseases like lupus (Marwa *et al*., 2025).
Type IV (Delayed-Type Hypersensitivity): T-cell responses are involved; symptoms occur within 48-72 hours following exposure in contact dermatitis (Cooper & Novak, 2022).



2.3 Management Of Allergies And Hypersensitivity Reactions

Allergies and hypersensitivity reactions are a series of immune responses wherein the body reacts too strongly against foreign substances, which are usually harmless. Their management makes use of various types of techniques, each depending on the nature of the allergy and the severity of the reaction experienced.

1. Identification and Avoidance of Triggers: The initial management of allergy involves the identification and avoidance of allergens themselves. This may involve a detailed diary of symptoms and exposures, along with allergy testing (American Academy of Allergy, Asthma & Immunology, 2021). Common allergens include the following: Pollen, dust mites, animal dander, foods- including nuts and shellfish- and insect stings. Given that allergen avoidance is not always practical, common avoidance strategies may include dietary changes, the use of hypoallergenic bedding, and modification of environmental factors (Sicherer & Sampson, 2018).

2. Drugs: Antihistamines: Are drugs that counteract the action of histamine, a body chemical implicated in allergic reactions, causing symptoms like sneezing, itchiness, and runny nose, among others. Examples include diphenhydramine and loratadine, among others (Bousquet *et al*., 2020).

Corticosteroids: They are drugs that reduce inflammation and thus can normally be used when the allergic reaction is excessively aggressive. They can be given topically, orally, or via inhalation depending on the site of action affected (Rosenfield et al., 2023).

Decongestants: These relieve nasal congestion and are useful in the management of allergic rhinitis (Rosenfield *et al*., 2023).

Leukotriene receptor antagonists: Drugs like montelukast block leukotrienes-chemicals associated with airway inflammation and hypersecretion of mucus-thus helping in the management of asthma and allergic rhinitis (Kumar *et al*., 2013)

3. Immunotherapy: Immunotherapy is a procedure through which the body's immune system is desensitised to certain allergens. This is accomplished by the following: Allergy shots (subcutaneous Immunotherapy): Tolerance to allergens can be developed when one undergoes regular injections in increasing doses (Melnikova *et al*., 2024).

Sublingual Immunotherapy: This is the process of placing tablets or drops containing allergens under the tongue. Less invasive, sublingual Immunotherapy has been proven effective against specific allergies, including grass pollen (Durham *et al.,* 2019).

4. Emergency Anaphylaxis Treatments: Anaphylaxis is a severe and potentially fatal allergic reaction that requires immediate action. It includes the following: Epinephrine: through an auto-injector (e.g., EpiPen); this is an initial line of treatment that can act very quickly in reversing symptoms of this condition (Wang *et al*., 2023) explain that oxygen therapy should be undertaken in case the patient experiences respiratory distress (Rosenfield *et al*., 2024). Intravenous fluids and corticosteroids: these may be administered in a hospital-based setting for the management of severe reactions (Wang *et al*., 2023).

5. Education and Support: Education of the patient remains cardinal to the effective management of allergies. Patients need education on symptom identification, understanding their triggers, and on seeking medical help when necessary (Bousquet *et al*., 2020). Support groups and counselling will also go a long way in helping them cope with the emotional challenges of patients with allergies.

3.0 LABORATORY DIAGNOSIS

Diagnosis of allergies and hypersensitivity reactions depends on clinical evaluation as well as laboratory tests. The diagnosis, for proper treatment and management, should be as exact as possible. The following are the major laboratory diagnoses of allergies: 1. Skin Testing: SPTs and intradermal tests remain the most widely used methods for investigating IgE-mediated, immediate hypersensitivity reactions.

i. Skin Prick Test (SPT)

This is performed by applying small amounts of allergens to the surface of the skin, which can enter with small pricks. A wheal-and-flare response, which may indicate positivity, suggests hypersensitivity to the putative allergen tested (Wong *et al*., 2021).

ii. Intradermal Testing: Intradermal tests are more sensitive than SPT and involve the intradermal injection of a small amount of allergen. This is usually done when the SPT results are negative, but there is still a high level of clinical suspicion (Bousquet *et al*., 2020). Normally, skin testing is safe and allows quick results; however, it is contraindicated for all patients with widespread eczema and certain conditions of the body.

3.2 i. Serum-Specific IgE Testing

Serum-specific IgE tests quantify IgE antibodies against specific allergens in the blood. Such tests help patients who, for various reasons, cannot be skin-tested either because of some dermatological conditions or due to antihistamines that interfere with the results of a skin test (Melnikova *et al*., 2024).

i. Radioallergosorbent Test (RAST): This is a blood test that quantifies IgE levels against certain specific allergens (Melnikova *et al*., 2024).

ii. ELISA: This is an assay that can also be employed in the measurement of the level of specific IgE in the serum (Jutel *et al*., 2023). These tests are identified, this is particularly useful in the diagnosis of food and drug allergies, among other forms of sensitivities, where skin testing cannot be employed.

3.3 Testing for Total Serum IgE

Total IgE testing is a test of the blood that measures the general level of IgE in the blood. While increases in total IgE may indicate the presence of allergic conditions, it does not indicate specific allergens themselves. Because of this fact, this test is usually combined with other tests (Holgate *et al*., 2018). Increased total IgE unrelated to allergic conditions may also be seen, as in parasitic infections or other hematologic disorders (Melnikova *et al*., 2024).

3.4 Provocation Tests

These are tests in which the suspected allergen is administered to the patient in a controlled environment, observing the occurrence of a reaction. These tests are said to be a gold standard in diagnosing certain allergies, especially food allergies, though they bear a high risk of anaphylaxis and should only be conducted in specialised medical settings (Rosenfield *et al*., 2023).

3.5 Patch Testing

Patch tests are delayed-type hypersensitivity reactions or, in other words, contact dermatitis. Different allergens are usually placed on patches, which are applied to the skin for about 48 hours, and then the skin reaction is observed for detection (Wong *et al*., 2021). This technique is thus of great significance in the diagnosis of allergies against metals, perfumes, preservatives, and many others.

3.6 Basophils Activation Tests

Such tests detect the reaction of basophils-white blood cells-to certain allergens. This test is mainly used in difficult cases when conventional tests may not give accurate results. It involves testing the discharge of mediators from the basophils after exposure to allergens (Jutel *et al*., 2024).

4.0 Conclusion

Allergic disorders and hypersensitivity reactions are a leading public health concern, afflicting millions of people worldwide. There are complex, multifactorial conditions involving both genetic and environmental factors. While the immunological mechanisms underlying different types of hypersensitivity reactions are well-established, continued research is essential for improving diagnostic methods and developing more targeted, effective treatments. The rise in allergic conditions globally underscores the need for ongoing communal health efforts and individualised patient care strategies to address these increasingly common disorders.

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