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The Chemistry of Allergies

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B Y H E N R Y D A L E Y

the CHEMISTRY of ALLERGIES

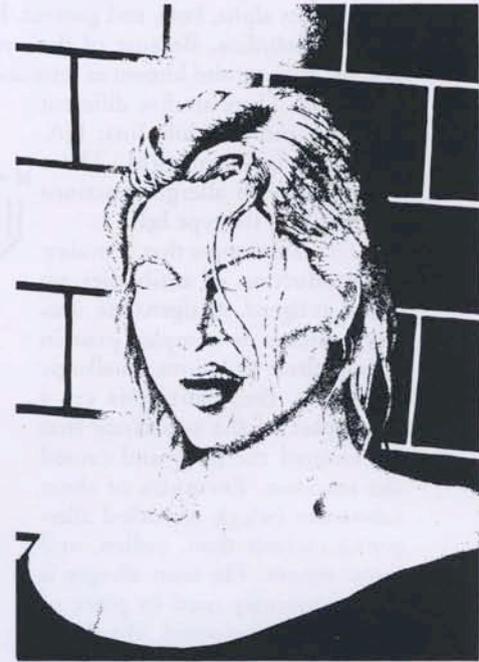


Illustration by Miriam Walsh

Each year in the United States, over 5000 people die from bronchial asthma, 40 from insect stings, and around 300 from ordinary doses of penicillin. The reason: allergies. Allergies are the fourth most common activity-limiting chronic disorder and may constitute the most prevalent disease found in the United States. It is estimated that over 20% of Americans suffer from allergic reactions sometime in their lives. The extent of this reaction can be very mild to life-threatening. In fact some reactions are so mild that the person having the reaction may not be aware that he or she is experiencing one.

What is an allergy?



The answer to the question, exactly what an allergy is, is not known. What is known is that some peoples' bodies overreact to the presence of certain substances. These substances produce no ill effect in most humans.

The chemical basis of the human body's ability to overcome diseases is the production of antibodies. These are complex protein structures known as globulins. There are three basic types of globulins alpha, beta, and gamma. Most antibody molecules are gamma globulins. Because of their relationship to the immune system, they are also known as immunoglobulins and are given the symbol Ig. There are five different types of immunoglobulins: IgA, IgD, IgE, IgG, and IgM. Those associated with allergic reactions are mainly of the type IgE.

Substances that stimulate the production of antibodies are called antigens. Antigens are usually proteins or complex protein carbohydrate structures. In allergic reactions, these antigens are a small part of the substance that has entered the body and caused the reaction. Examples of these substances (which are called allergens,) include dust, pollen, and insect venom. The term allergen is also sometimes used in place of antigen. In ragweed, the chief antigen represents about 0.5% of the total mass of the solid in the pollen. It is known as antigen E. An injection of 1×10^{-12} grams of antigen E is enough to cause a response in allergic people.

Cells in the body analyze these antigens and transfer information about them to other cells that produce the antibodies. These antibodies attack a specific antigen and have little or no effect on other antigens. The antibodies remain in the bloodstream after the antigen is removed. The IgE antibodies are responsible for many of the most common allergic reactions such as hay fever, asthma, anaphylaxis, hives and eczema.

No one is born with IgE antibodies in their body. When first exposed to an allergen, it takes about 10 days before the IgE is developed. By this time the allergen is gone so no allergic reaction occurs. A second or later exposure to the allergen causes the allergic reaction. It takes repeated exposures to allergens for people to develop an allergy.

The Role of IgE



IgE is not a single protein structure (molecule), but a class of molecules each having a slightly different structure. Each molecule reacts with a specific antigen. This is why people have specific allergies. The IgE that reacts with ragweed is not the same form of IgE that reacts with the antigen from a bee sting.

IgE is present in the body in extremely small amounts, about 1 part per million in blood plasma. People who have allergic reactions have more IgE present than normal. For example, a person with allergic asthma has six times as much IgE as one with non-allergic asthma and those who suffer from hay fever have 14 times as much IgE as non-allergic people.

The tail of an IgE molecule (which is Y shaped) attaches itself to certain cells in the body known as mast cells. A single mast cell can bind more than 100,000 IgE molecules. Within the mast cells are granules that contain chemicals known as mediators. When an allergen combines with an IgE molecule on the mast cell, the mediators are released. Although numerous different chemicals are present as mediators, only two of them appear to play a role in human allergies. These are known as histamine and slow reacting substance (SRA-A). Of these two, histamine is the chemical responsible for the side reactions we associate with allergies such as itching, swelling, and runny-nose.

Basic Types of Allergies



There are four ways in which allergens invade our bodies. They can be (a) inhaled, (b) ingested (eaten or drunk), (c) touched (skin contact), and (d) injected (sting or bite). Once the allergen is present in the body, there are two different types of allergic reactions. They are classified as immediate or delayed, depending upon the time it takes for the allergic reaction to appear.

An immediate reaction is one in which symptoms appear within minutes after exposure to the allergen. Where as in a delayed reaction it takes at least four hours or sometimes even days after exposure for the symptoms to appear. Typical of delayed reactions are

contact allergies such as perfumes in soaps, poison ivy, and organ rejections.

Different mechanisms are at work in the two types of allergic reactions. The mechanism described above applies to immediate allergic reactions. However in delayed reactions, no antibodies are found in the blood; instead delayed reactions are believed to be mediated by cells. Many of the delayed reactions involve the other types of immunoglobins. IgG is involved in the Rh factor associated with newborns and with allergic pneumonia. IgA and IgM have been associated with allergic reactions involving blood vessels and the kidneys. Both IgA and IgE are involved with food allergies which usually occur in people who lack IgA. IgA blocks food allergies by combining with the allergen associated with these allergies.

Although it is often assumed that certain types of allergic reactions can be triggered by stress and emotional reactions, this is not true. Stress and emotions can intensify a reaction, especially in bronchial asthma and hay fever but cannot initiate a reaction. However, there is a correlation between heredity and allergies. If one of your parents has allergies, there is a better than normal chance that you will have an allergy. If both your parents have allergies your chance of having similar allergies is about 80%, although it may not necessarily be the same allergy as your parents.

Antihistamines	
Generic name	Brand Name
Astemizole	Hismanal
Brompheniramine	Dimetane
	Sinsusol-B
	Generic
Chlorpheniramine	15 different brand names
	Chlor-Trimeton
	Generic
Dimenhydrinate	20 different brand names
	Dimetabs
	Dramamine
Diphenhydramine	18 different brand names
	Benadryl
	Nytol with DPH
	Sominex Formula-2
	48 different brand names
Terfenadine	Seldane
TriPelennamine	PBZ
	(Pyrobenzamine)
Tripolidene	Pseudophred

Illustration by Laurel Lawson

The Role of Histamine



Histamine, formed by the breakdown of a common amino acid known as histidine, is found in high concentrations in the granules in mast cells, and is released as the granules move to the outer edge of the mast cell. They discharge the histamine through a temporary gap in the cell membrane.

In immediate reactions, histamine can account for many, if not all, of the symptoms associated with an allergic reaction. Histamine causes dilation of the blood vessels and increases the ability of blood fluids to leak out of capillaries. These fluids are responsible for the swelling of tissues. Histamine also causes contraction and swelling of the smooth muscles, stimulates the production of saliva, tears and secretes mucus. It can also cause a large drop in blood pressure and produce a condition known as anaphylactic shock, leading to death.

Treatment of Allergies



Three procedures are used in the treatment of allergies: (a) avoidance, (b) desensitization, and (c) chemicals. Once a person knows what material he/she is allergic to, the best treatment is to avoid the allergen as much as possible. In some cases it would seem that moving to a different part of the country might help, especially with pollen allergies, but in general this does not work. People with hay fever who move from a part of the country high in pollen to one low in pollen often develop an allergy to the different pollens found in their new home.

Desensitization therapy involves the injection of an increasing amount of allergen if the person has a high IgE concentration. The modern term for desensitization is hyposensitization, which means reduced sensitivity. Small amounts of allergen are injected over a period of weeks. Benefits are not apparent until six to twelve months of treatment. Injections should be given in a doctor's office because of the possibility of a severe reaction (anaphylaxis) to the injection. It may seem strange to inject a person with the same allergen that is causing the problem, but the procedure appears to work by increasing the amount of IgG antibodies in the body. These antibodies block the combination of the allergen with IgE, preventing the release of the chemical mediators. This procedure is particularly useful for allergies to bee, hornet, and wasp stings, and is effective for pollen allergies.

Chemical treatment involves three different classes of drugs: Epinephrine (adrenaline), steroids, and antihistamines,

Antihistamines



Antihistamines are probably the best known and most widely distributed class of chemicals used to relieve the symptoms of allergies. Over 50 different antihistamines are available in the United States,

often combined with decongestants or analgesics in cough medicines.

Antihistamines do not cure allergies. They work by competing with histamine for sites on cells. By blocking the histamine from these sites they prevent the swelling, itching and other symptoms associated with the reaction of histamine with the cells. The early histamines can pass through the brain membrane and cause drowsiness, which has led to their use as sleeping medications. Two of the newer antihistamines, astemizole and terfenadine, cannot cross this barrier, and thus do not cause drowsiness. Other serious side effects have recently been associated with these antihistamines.

The reason there are so many antihistamines is that each affects different people in various ways. Only by working with your doctor can you determine which is the best for you to take.

Epinephrine



Epinephrine (adrenaline) was the first strong drug sold for the treatment of allergies. It relaxes the muscles in the bronchi and thus is effective in bronchial asthma. When people are rushed to the hospital with a severe allergic reaction, epinephrine is injected. This has saved the lives of many people who have suffered anaphylactic shock due to a reaction to an allergen. Epinephrine is known as a sympathomimetic drug, as it stimulates the sympathetic nervous system along with relaxing the smooth muscles.

Numerous other compounds are also used as sympathomimetic chemicals: better known are noradrenaline (norepinephrine), ephedrine and isoproterenol. The xanthines and theophylline are similar. Theophylline is often used in inhalants as a bronchial dilator. It is also used to determine lung capacity. Some patients with bronchial problems feel they can breathe better after drinking a cup of coffee. This happens because theophylline is one of the hundreds of chemicals found in the vapor of coffee.

Steroids



Adrenocorticoids (corticosteroids) are also very important in treating allergies. Some of the more common steroid drugs used are hydrocortisone, prednisone, betamethasone, triamcinolone, and flucinolone. They help relieve the redness, swelling and itching associated with allergic reactions and are especially useful for bronchial asthma, hives, eye disorders, and eczema. Steroids reduce the swelling and fluid build-up associated with the allergic reactions and are so powerful they may be used in severe cases of bronchial asthma.

To learn more about allergies and the drugs that are available to combat allergies the following research guides are invaluable: *The Complete Drug Reference*, Consumer Reports Books, United States Pharmacopoeia, 1992 and *Allergy: Its Mysterious Causes and Modern Treatment*, The Allergy Foundation of America, Grosset and Dunlap, also see *Chemical & Engineering News* "Allergy, A Protective Mechanism Out of Control," May 11, 1970 pp 84-132. For those of you who suffer from allergies, remember, significant strides have been made and will continue to be made to help you face up to the watery eyes, the sneezing, the general discomfort and in some cases the danger associated with allergic reactions.



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