University of Basel

Allergies: When the Immune System Backfires

Video Transcript

A complex network II: components that interact

[Andreas J. Bircher]: Let us now categorise the different components at work in our immune defence. The first category designates barriers, be they mechanical, physical, chemical, or microbial. The second one includes all immune cells and the third one, the soluble factors.

The first in line are the mechanical barriers, surface organs, like our skin, or the mucosas that cover mouth, intestines, nose, lungs, or our eyes. These barriers either seal organisms as far as possible from their environment or enable the expulsion of irritants mechanically. In fact, when you sneeze or cough, you eject pathogens mechanically. Tears, as well as urine, also expel pathogens. Our skin produces small molecules, for instance, the defensins that may kill bacteria. The pH of the stomach also destroys germs. Both are examples of the chemical barrier.

The second category encompasses all cells of the immune system. They are generated in the bone marrow from precursor stem cells, the myeloid and the lymphoid line. We discern two categories amongst the immune cells, those that mainly act in innate immunity and the others that act in adaptive immunity. Let us observe them in action. Some microorganism has succeeded in penetrating the barriers. As it enters, an alarm system is set off. It warns innate immune cells that are close to the location of entry, mast cells, macrophages, and dendritic cells. Circulation brings further cells to the location under attack, neutrophils, eosinophils, and basophils. These cells belong to the family of the granulocytes. In addition, a cell called natural killer acts against the invader. These innate defence cells work by pattern recognition system. They are targeted towards commonly occurring molecules on particular intruders. In an evolving ecosystem, an immune defence needs to provide cells that may learn and adapt to new pathogens. The adaptive cells encompass two kinds of lymphocytes. On the one hand, there are B cells. Their first contact with an intruder may have the following consequences. A B cell first recognises the particular antigen. It gets a boost by a T helper cell and then turns into plasma cells, secreting antibodies that are specific to the intruder's antigen. At the same time, memory B cells are generated. Memory B cells stage an immune reaction in just a few hours should they meet with the same antigen again. On the other hand, in the lymph node, antigen presenting cells pass information to naive T cells. They recognise, engulf, and present foreign intruders to T lymphocytes in a manner comparable to the B cells. A so-called naive T cell develops into T helper or cytotoxic effector cell. These cytotoxic T cells move on to aggressive agents decisively ones let loose by the organism. Antigen presenting cells pass information to T cells and B cells. They recognise, engulf, and present foreign intruders to the lymphocytes. All these cells differ in respect to their location. Mast cells, macrophages, and dendritic cells prevail in skin and mucosas, the sites where a first encounter with intruders is most likely. Lymphocytes, that is B cells and T cells, are primarily found in lymphatic tissues. Finally, granulocytes, neutrophils, eosinophils, and basophils, and natural killers are patrolling. Thus, they are found predominantly in circulation.

In addition to organs and cells, there is a third component completing the immune defence, the so-called soluble factors. They function as couriers that help to spread information throughout the system. Soluble factors include numerous messengers, such as cytokines. Cytokines allow stimulation, activation, and communication among cells. The group of cytokines includes interleukins, chemokines, interferons, and growth factors. Interleukins help to stimulate and communicate between immune cells. Chemokines attract immune cells and induce migration to the site of inflammation. Interferons are mainly produced in

response to viral or bacterial infections, and hematopoietic growth factors stimulate the production of immune cells in the bone marrow. The complement system is a very old part of innate immunity involving specific proteins. It also links the innate and the adaptive immune system. Once triggered by a pathogen through different pathways, it uses a cascading process to boost antibodies and phagocytes in a way that helps them to remove microbes and damaged cells. The antibodies finally are part of the adaptive immunity. They bind specifically to antigens. The soluble factors basically mediate information among the different cell types. They thus support the innate defence by mounting a specific and adaptive response. As a side effect, this mediation may translate itself into symptoms in the patient – local pain, redness, and swelling. Or the cytokines interferon gamma or interleukin 1 cause the symptoms in systemic inflammation – fever, myalgias, and chills.

As we have observed, there are two basic defence lines in the immune system, the innate and the adaptive one. Recapitulating them allows us to summarise the components we have addressed. If a foreign and possibly noxious agent is detected by the immune system, it first reacts by activating instantaneously its inborn components. This defence line includes mechanical, physical, chemical, and microbial barriers, soluble components like defensins and cellular elements like mast cells, macrophages, and neutrophils. A rapid nonspecific response is initiated with cells that are not able to develop memory and therefore form the so-called innate system. The second defence line is slower in action. It is highly specific. It is able to create a memory and belongs therefore to the acquired or adaptive immune system. This system either uses components like antibodies from B cells found in blood serum or mucosas, or it induces specific T cells highly targeted towards the agent that should be neutralised. Thus, we have created a very general map of the immune system, a cartography of its components.