



Allergies: When the Immune System Backfires

Video Transcript

Introducing the metaphor

Imagine the type of mediaeval fortress often encountered in fantasy realms. It is the home of a valiant garrison that protects it from the aggressions of a motley group. Mythical beasts like dragons or centaurs, but also animals like cranes or crocodiles.

As a model of the immune defence, the analogy has its limitations. It is not able to describe every detail of immunologic events. However, a walk-through might help you train your memory. Therefore, I invite you to accompany me on an exploring tour.

Before we enter the buildings, I would like to draw your attention to the flags floating in the wind. They show the crest of the lord in charge. The crest helps to discriminate between self and foreign, friend and foe - an important prerequisite for a successful fight. The immune defence uses HLA, also called MHC molecules, for the same reason. These molecules help to distinguish what is alien to the organism from what belongs to it.

As we have asked him quite humbly, his lordship whom you will have the pleasure to meet in an instant, has graciously granted us fly-over rights. This allowed me to map the premises for you. Seen from above, it is quite evident how the structures echo the immune system of a stylized organism. The water in the moat corresponds to the defensins and the lysozyme. The castle wall might be interpreted as the skin barrier. The towers represent the lymph nodes. The gate with its tower compares to the mouth and tonsils. Inside, you find the donjon as the centre of the system. We might compare it to the thymus. The workshops are analogous to the bone marrow. And obviously, the kitchen reminds us of the gastrointestinal tract. Without a strong garrison, however, all these structures are of little value.

I am thus very honoured to introduce you to Adalbert who governs this castle. My lord. In the immune system, his position would be occupied by an antigen-presenting cell, APC. For instance, a Langerhans cell or a dermal macrophage. Adalbert decides who is friend, who is foe. He identifies the enemy, initiates, and directs the defence. My lady. Meet Regula. Her equivalent in the immune system would be the T-regulatory cell. This cell modulates the immune response, while my lady here calms down bloodthirsty knights.

Let us now turn to the first line defence combatants. Please meet Nemo the Numerous. Nemos correspond to the neutrophilic granulocytes. Like them, they are the first to attack. And like them, they die in the effort, sacrificing themselves. Neutrophils attack bacteria and ingest them. They leave behind inflammation and pus, comparable to the bloody battlefield from which this group departs. Gentlemen. And this is Erik the Red. He fights with a mace and helps to eliminate larger attackers. The immune system knows such competence as eosinophils. They engage with toxic substances against foes that cannot be easily conquered by other cells alone. Large parasites would be an example of such aggressors. Nemos and Eriks arrive quickly in the battle arena using paths that lead like the blood vessels through the castle.

The next fighters are the sentinels. This is Magnus the Magnificent, standing guard on all walls and lookouts. He is among the first to alarm the other warriors, if he encounters a foreign intruder. In the immune system, he would correspond to a stationary mast cell within the skin or the mucosae of the lungs and the intestine. Magnus has to stay on his post. Come what may, he is never allowed to leave it.



Comparably, Martellus the Mighty lingers close to the ramparts. He supports Magnus and knocks down intruders on the battlements and at the gate before they cause greater harm. This corresponds to the functions of macrophages engulfing bacteria. They are supported by natural killer cells that circulate and mercilessly attack any intruder they recognise as foreign.

Let us now go to the towers and meet another important troop. Archers and knights are highly trained force. Both have the competence to hone their skills to adapt them to a specific foe. As soon as Adalbert has identified an enemy, he orders either one of them to attack. They then start to practise recognising and killing this particular intruder. They do this either with their arrows or their swords. In the immune system, archers would be B or plasma cells. Their arrows correspond to their antibodies. The brave knight finds an analogy in T cells, his sword in the so-called T-cell receptor. There are several other specialised knights and T cells, but our visit is timed, so let us focus on the gentlemen at hand.

Observe the crest on their armour-- a first means of communication, as it helps to discern friend from foe. For their training, they need some time. In the immune system, the sensitization phase has a typical duration from five to seven days. Once trained, however, the archers and knights strive to be well-prepared. Should the enemy to which they have adapted to strike again, their time to respond is much shorter. In the immune system, B cells attack from distance and may release the specified antibodies already after some minutes. T cells are slower-- they need one to two days to get in close contact and attack the enemy. The castle's lady, Regula, keeps a close eye on the archers and knights. Should they start to go berserk, she calms them down.

Give me a break!

The members of the garrison communicate with gentle flutes if they address their direct surroundings. For farther reach, they use loud trumpets and trombones. Accordingly, the immune system uses chemokines for local communication and cytokines for more distant signalling. Last, but not least, there are some deadly but not very precise weapons. Put yourself into the skin of an aggressor who tries to scale the ramparts with a ladder. The defenders will burn you to death with heated substances or throw heavy boulders and trunks--

[Attacker] Arrgh!

--on you.

[Defender] Sorry.

The innate immune system does this feat with lysozyme and defensins that would correspond to boiling water and pitch. And the complement might be envisioned as boulders.

I hear that an attack is imminent. There are vicious dragons on the horizon. In order to guarantee your safety, let us retreat to our tour bus. There, you may read the next article addressing enemies and dangers to the castle.