Title: Immune Privilege: The Eyes Have It

Post Blurb: How does your immune system protect vulnerable parts of your body like your eyes? It gives these special parts Immune Privilege.

Post Description:

Title Image:

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Article:

What do you picture when you think of your immune system? One picture could be your own personal army, courageously defending you against foreign bodily threats. While a strong immune system provides you with protection from infections and disease, this robust protection can come with collateral damage to your body(*1*, *2*). Much like the siren on a fire truck, the inflammation that occurs during an immune response serves a dual purpose(*1*). First, the siren, or inflammation, clears a path for help to get to the site of trouble as quickly as possible and second, it also indicates that something is wrong; that there’s a threat to contain. Despite its helpfulness to a fast and strong immune response, **inflammation can damage bystander** **(uninfected or uninjured) cells**(*2*, *3*).

Most of your body is capable of regenerating itself. For example, your stomach lining replaces itself every 2-9 days, your skin replaces itself every month, and you recycle your red blood cells every 4 months(*4*). However, certain parts of your body, like your **eyes**, brain, and central nervous system are unable to regenerate themselves or take a long, long time to do so(*3*, *4*). Since **the eyes’ and brains’ regeneration capacity is limited** and their purposes ( vision and thinking) are very advantageous to life (without either of these functions, you’d have a hard time reading this blog article), these parts of your body can’t afford collateral damage from a protective immune response (*3*). These parts of your body need special treatment, or “immune privilege”(*2*). Another part of the body that gets special treatment is the pregnant uterus containing a fragile fetus(*2*). A fetus is foreign to the mother’s body and its’ developing nature makes it very sensitive to damage and thus it also gets “immune privilege” (a very good thing for our species survival) (*2*). **Immune privilege** is an adaptation by our immune system that enables different immune defenses and protection that avoid causing damage and death of bystander cells(*5*). This article will focus specifically on the immune privilege of your eyes.

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Your eyes’ immune privilege status is maintained by three mechanisms(*6*):

1. Physical and Chemical Barriers

2. Suppressive Environment

3. Limited Adaptive Immune Response

Physical and Chemical Barriers Protect Your Eyes

Tears are the first barrier a pathogen must cross if it wants to infect and damage your eyes(*7*). When you blink, tears coat your eyes and wash pathogens out(*7*). Besides physically washing out pathogens, tears also contain antimicrobial peptides and lysozyme to quickly kill pathogens(*7*). [Antimicrobial peptides](https://thedishonscience.stanford.edu/posts/amp-immune-foot-soldiers/) are a diverse group of proteins that kill pathogens but not your own cells and are one of the earliest defenses of your immune system(*8*). Lysozyme is an enzyme that kills some types of pathogens and makes up 1/3 of the proteins found in your tears(*7*). Your tears also contain IgA, a specific type of antibody(*7*). An antibody is a special type of molecule made by B cells, a type of immune cell that helps to kill infected cells, like a Wanted Ad that’s stuck to a criminal(*9*). In your eyes, the IgA antibody binds to pathogens before they enter host cells, preventing the host cells from getting infected(*7*). Your tears both physically and chemically protect your eyes from pathogen invasion.

Your iris (colored part of your eye) is a another kind of physical barrier that T cells (a type of immune cell) must pass through once they enter your eye(*5*). The iris barrier doesn’t prevent immune cells from entering your eye but it does limit their aggression(*5*). T cells that pass through this physical barrier have lost their aggression and are neutralized, like soldiers who put the safety on their guns and are told to stand down. The cornea barrier is even more strict, it limits activation of immune cells, suppresses inflammation, and even kills some immune cells to stop them from crossing into the eye (*5*). In other words, the cornea barriers forces soldiers to put the safety back on their guns, turns off the alarm signal and even forces some immune soldiers to kill themselves instead of causing damage and destruction in the eye.

The physical and chemical barriers protect your eyes from infection and support its immune privilege.

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Suppressive Environment Limits Inflammation to Protect Your Eyes

The vitreous humor and aqueous humor are like soup, but instead of being filled with chicken and noodles, they’re filled with molecules that suppress inflammation and its dangerous destruction(*5*). These suppressive molecules limit different immune cells’ activation and their production of inflammatory molecules(*3*). The humors of the eye muzzle weapons and muffle or stop alarm signals to prevent bystander destruction, controlling the immune response.

Besides the suppressive humor soup, the cells of your eyes also have some molecules on their surfaces to limit inflammation(*3*). They have surface markers called FasL and TRAIL that kill activated immune cells like T cells(*3*). Your eye cells also have surface markers, CRP, that stop inflammation cascade in its tracks to prevent your eye cells from being damaged during an infection(*3*). In addition to those suppressive surface markers, your cells have unique MHC1 identifiers(*3*). Almost every cell in your body has MHC1 surface molecules that constantly say “I am you, I belong here!”(*1*). When you get infected with a virus, the MHC1 surface molecule changes its tune to “I’m infected, help me, kill the invader!” by showing the virus to passing immune cells or disappearing so no message is said and your immune system gets suspicious of the silent treatment and investigates (*1*). Your eyes don’t express the typical MHC1 molecules and thus they won’t say, “I’m infected, help me, kill the invader!” and get killed(*3*). Instead, your eyes have unique MCH1 molecules, HLA-G and HLA-E, that say, “I am you, I belong here…Don’t kill me!” and HLA-G and HLA-E don’t disappear during an infection so no investigation by immune cells takes place(*3*). The cell surface markers on your eyes’ cells prevent bystander cell death and suppress inflammation.

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Your eyes live in a suppressive environment that controls and subdues the amount of inflammation to protect your eyes and support their immune privilege.

Limited Adaptive Immune Response Protects Your Eyes

An adaptive immune response is an immune response to a specific threat and is carried out by T and B cells(*1*). There are two main cell types involved in adaptive immune responses: T cells and B cells(*1*). In other parts of your body that are not immune privileged, B and T cells are free to act to protect you during an infection or threat. In your eyes, only B cells (and even then, only a certain type of B cell) are free to protect your eye with its antibodies(*2*). If your eyes were a command operation, only one type of sniper would be allowed to shoot and even then, only with a semi-automatic gun to limit the damage and to ensure the right threats are neutralized. Both barriers and the suppressive eye environment inhibit T cells from acting by ordering them to stand down and sometimes disarming them.

The eye also interacts with your immune system to generate a special kind of T cell, a regulatory T cell (T-reg) to further protect your eye from inflammation and damage(*2*). Regulatory T cells act like the military police, they keep soldiers in line and curb disobedience to orders. In your eyes, regulatory T cells keep the other T cells under control and stop them from causing inflammation or from killing your eye cells(*2*). The limited adaptive response also allows for your eyes to better accept foreign tissue, like with cornea transplants(*5*, *6*). Cornea transplants have the highest success rate of acceptance out of all the organ transplants and don’t require matching (unlike bone marrow) or additional medication to suppress your immune system(*6*). Part of the reasons for the success in cornea transplant is the modified adaptive immune response helping to protect the transplant tissue.

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Concluding Remarks

If the eyes are the window to the soul, then your immune system ensures this window is protected from smears and shattering. **Immune privilege** is an evolutionary adaptation by our immune system that allows for modified immune responses to avoid causing damage and death of vital bystander cells(*5*). Your eyes are immune privileged because your eyes’ cells are unable to regenerate and they carry out the advantageous function: vision. This immune privilege is rarely overwhelmed except to avoid the death of the individual when the case of blindness or vision impaired would be the lesser risk (*2*). Overall, immune privilege shows how capable your immune system is and how well your immune system protects all parts of your body, even parts that can’t afford collateral damage and thus need special treatment, like your eyes.

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