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Matrix no:17/mhs02/068

Explain the major role of the immune system

Abstract

The major function of the immune system is to protect the host from environmental agents such as microbes or chemicals, thereby preserving the integrity of the body. This is done by the recognition of self and response to non-self. The immune response has been artificially divided into innate immunity (resistance) and specific immunity. Specific immunity is further divided into humoral immunity, the one involved with antibody, and cellular immunity, which is orchestrated by T cells. It is essential to understand that although these divisions have

helped in understanding and analyzing the immune response, the system functions as a single unit rather than as a separate entity. In this paper, a simplified analysis of specific immunity will be given. However, the importance of nonspecific immunity, especially as it pertains to its role in preventing exposure of environmental substances, should not be forgotten.Two types of immunity exist — active and passive:

- **Active immunity occurs when our own immune system is responsible for protecting us from a pathogen.**
- **Passive immunity occurs when we are protected from a pathogen by immunity gained from someone else.**

Both of these different types

of immunity can be acquired in different ways.
A third category, community immunity, does not involve physical components of the immune system for protection, but is still worth discussion in this capacity.

Active immunity

Individuals rely on active immunity more so than passive immunity. Active immunity is created by our own immune system when we are exposed to a potential disease-causing agent (i.e., pathogen). Most of the time, we are exposed to these potential pathogens naturally throughout the course of our day — in the air we breathe, the food we eat, and the things we touch. Luckily, most of these exposures are to agents that will not result in disease, either because they

are harmless or because our immune system works to neutralize them.
In addition to "fighting off" these pathogens, active immunity is important because it lasts a long time in the form of immunologic memory. Immunologic memory consists of B and T cells that can recognize a particular pathogen (see "Adaptive immune system"). These cells circulate at low levels in our bodies and if "activated" by recognizing that pathogen in their travels, they quickly start to multiply and signal other elements of the immune system to activate as well. Memory cells are crucial for two reasons. First, they allow our immune systems to respond quickly. Second, they are specific for the pathogen, so the immune response is ready the moment

the pathogen is encountered (see "Immunologic memory"). Because we don't know about most of the work our immune system does, we often do not think about how busy it is. But, the reality is that like our hearts and lungs, our immune system is constantly working to keep us healthy. This effort is evidenced by the fact that our immune system generates grams of antibodies every single day!

Vaccines contribute to active immunity by providing us with a controlled way to create an immune response. When a vaccine is introduced, our immune system treats it like any other exposure. It works to stop the "assault" and, in the process, immunologic memory develops. Because vaccines are designed such that they do not cause illness, we gain the benefits of the

exposure without the risks associated with fighting off a natural infection. In this way, vaccines offer our immune systems a chance to “train” for a future encounter and provide us with a “shortcut” to protection. We gain the immunity that follows surviving a natural infection without having to pay the price of natural infection.

Passive immunity

Passive immunity, or immunity gained in a way other than from one’s own immune system, can occur in a few ways and can be life-saving. However, passive immunity is short-lived because the antibodies are not continually replenished as they would be in an individual whose immune system is responding directly. Passive immunity can occur in a

couple of ways:
Maternal antibodies
Unborn and newly born babies are protected by antibodies from the maternal immune system.

These antibodies are shared in two ways: across the placenta and in breast milk.

- **Placenta and circulation — When a woman is pregnant, her blood circulates through the placenta to deliver nourishment and protection to the developing fetus. As the blood circulates, so do the antibodies and immune system cells that travel in blood. Although developing fetuses are not typically exposed to any pathogens *in utero*, they are exposed to viruses and bacteria during and**

immediately after birth. The types and levels of antibodies in a baby's blood at birth reflect those of the mother.

- Breast milk — Babies also get antibodies from breast milk, particularly from a protein-rich version of breast milk supplied in the first few days after birth known as colostrum. Colostrum, which is produced in the first three to five days after birth, contains higher levels of antibodies that protect the intestinal surface (immunoglobulin A or IgA) and lower levels of nutritional ingredients than milk produced in the weeks following birth. This transfer of antibodies from mother to child suggests its importance in the period before a baby's

immune system can generate its own protection.

Immunoglobulin treatments

In certain situations, antibodies obtained from animals, from other people, or synthesized in a laboratory can be used to treat individuals at risk of infections. For example, infants born to women infected with hepatitis B are treated with antibody preparations in addition to being vaccinated in an effort to protect them from also becoming infected with hepatitis B. In another example, people bitten by some poisonous snakes may be treated with antivenom, a mixture of antibodies against the type of snake venom to which the person was exposed.

Community immunity

Community immunity occurs when people are protected by those around them. This type of protection is indirect in that it does not involve physical components of immunity, such as antibodies, but rather results when a pathogen is less likely to infect a susceptible person because of the high numbers of protected people around them. Because this immunity is not based on “products” of the immune system, it is the least reliable. However, for some in our communities, such as those too young to be immunized or those with weakened immunity due to illness or treatment, community immunity is the only way they can be protected.

We generally talk about community immunity from

two perspectives — that of the community, commonly referred to as herd immunity, and that of the individual, commonly known as cocooning:

- Herd immunity

When enough people in a community have been exposed to a pathogen, it cannot spread as easily. As more people become immune, the pathogen has a smaller pool of people to infect. The result is that the community overall will have fewer outbreaks. Because not all pathogens spread with the same efficiency, the community levels of immunity necessary to benefit from herd immunity vary. For example, because measles is one of the most contagious pathogens known, a community requires almost everyone to be immune in

order to stop its transmission. Or said another way, it is much more difficult for an individual to benefit from herd immunity to measles than from most other infectious agents. Vaccines have made it easier for society to reap the benefits of this type of protection. Before vaccines, diseases continued to have susceptible pools of individuals — most often infants and young children not previously exposed to the disease. This is why childhood diseases and deaths were so common.

Cocooning

This type of passive immunity is similar to herd immunity, but is more often aimed at protecting a particular individual rather than a community. Ensuring that everyone around a young

infant is immune to a disease like pertussis (whooping cough) is an example of this type of indirect immunity. Another example is ensuring that everyone who visits or cares for a person being treated for cancer is healthy, so that the cancer patient whose immunity is weakened by treatment is less likely to be exposed to a pathogen.

Immunoglobulins are further broken down into four subclasses designated: IgG1, IgG2, IgG3 and IgG4 (listed in decreasing order of abundance in the serum). They share more than 95% sequence homology in the CH regions of the γ-heavy chains. There are also two subclasses of IgA: IgA1 (90%) and IgA2 (10%). Serum IgA is a monomer but is found

in secretions such as tears, mucous and saliva as a dimer. In secretions, IgA has a J chain and another protein called the secretory piece (or T piece) associated with it. In addition, several subclasses of κ and λ light chains are known to exist (1) .

Human antibodies are classified into five isotypes (IgM, IgD, IgG, IgA, and IgE) according to their H chains, which provide each isotype with distinct characteristics and roles.

IgG

IgG is the most abundant antibody isotype in the blood (plasma), accounting for 70-75% of human immunoglobulins (antibodies). IgG detoxifies harmful substances and is important in the recognition

of antigen-antibody complexes by leukocytes and macrophages. IgG is transferred to the fetus through the placenta and protects the infant until its own immune system is functional.

IgM
IgM usually circulates in the blood, accounting for about 10% of human immunoglobulins. IgM has a pentameric structure in which five basic Y-shaped molecules are linked together. B cells produce IgM first in response to microbial infection/antigen invasion.
Although IgM has a lower affinity for antigens than IgG, it has higher avidity for antigens because of its pentameric/hexameric structure. IgM, by binding to the cell surface receptor, also

activates cell signaling pathways.

IgA

IgA is abundant in serum, nasal mucus, saliva, breast milk, and intestinal fluid, accounting for 10-15% of human immunoglobulins. IgA forms dimers (i.e., two IgA monomers joined together). IgA in breast milk protects the gastrointestinal tract of neonates from pathogens.

IgE

IgE is present in minute amounts, accounting for no more than 0.001% of human immunoglobulins. Its original role is to protect against parasites. In regions where parasitic infection is rare, IgE is primarily involved in allergy.

IgD

IgD accounts for less than 1%

of human immunoglobulins. IgD may be involved in the induction of antibody production in B cells, but its exact function remains unknown.

Antibodies have three main functions:

1) Antibodies are secreted into the blood and mucosa, where they bind to and inactivate foreign substances such as pathogens and toxins (neutralization).

2) Antibodies activate the complement system to destroy bacterial cells by lysis (punching holes in the cell wall).

3) Antibodies facilitate phagocytosis of foreign substances by phagocytic cells (opsonization).