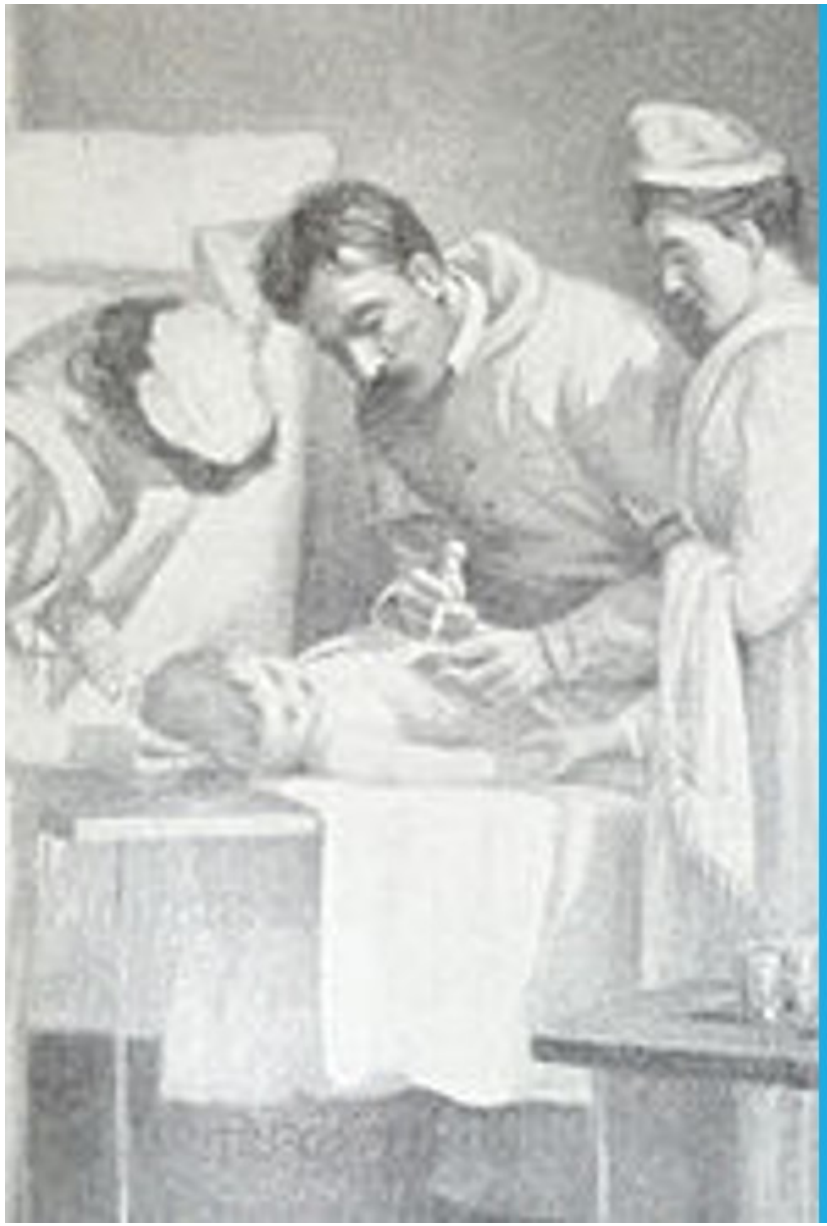
What is passive immunity and Immunoglobulins

PROF. MIN ZAW OO

SENIOR CONSULTANT PHYSICIAN

YANGON GENERAL HOSPITAL



Introduction

Introduction to the Immune System:

The immune system is our body's defense mechanism against diseases and harmful substances. It's a complex network of cells and molecules that protects us by identifying and eliminating threats like viruses and bacteria.

Explanation of Passive Immunity and Its Importance:

Passive immunity is immediate protection acquired externally, often through pre-formed antibodies called immunoglobulins. This is vital for rapid defense in scenarios like newborns or specific health threats.

The Immune System

The immune system, comprising intricate cellular and molecular components, functions to detect and eliminate invading Pathogens

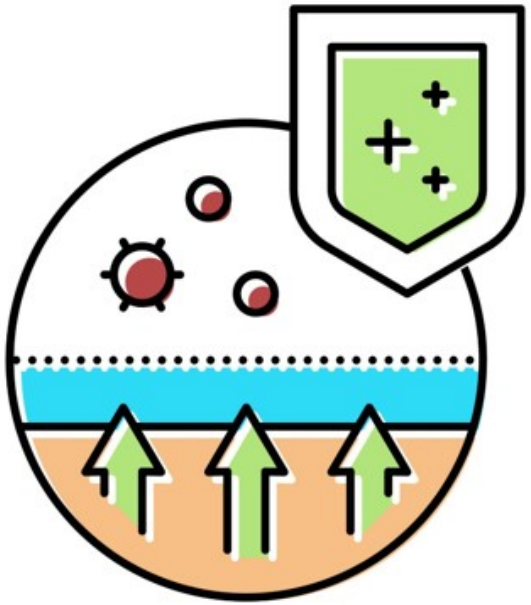
Through mechanisms like antigen recognition, antibody production, and immune cell activation, it orchestrates a defense against infections, shielding the body from harm.

A comprehensive understanding of these immune processes underscores the system's role in safeguarding the body against a diverse array of infectious agents.

Understanding Passive Immunity and Immunoglobulins

Passive immunity is an immediate but transient defense mechanism achieved through the introduction of exogenous immunoglobulins, specialized glycoprotein molecules produced by B lymphocytes, which exhibit a Y-shaped structure with antigen-binding regions for precise antigen recognition and neutralization.

The five predominant classes of immunoglobulins, IgG, IgM, IgA, IgD, and IgE, each play distinct roles in immune responses, contributing to the precision of immune defense mechanisms.

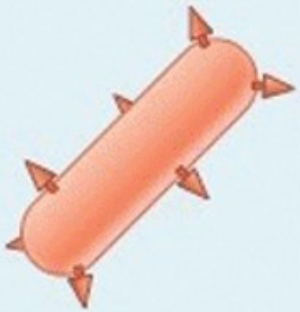
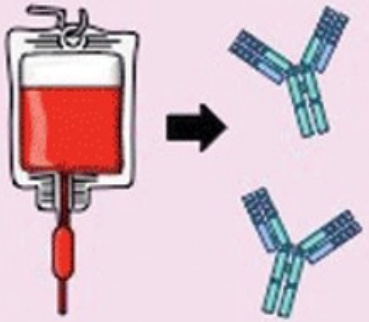


Active vs. Passive Immunity

Active immunity is initiated by exposure to antigens, activating the body's immune response, including B and T cells, resulting in the production of specific antibodies and immunological memory.

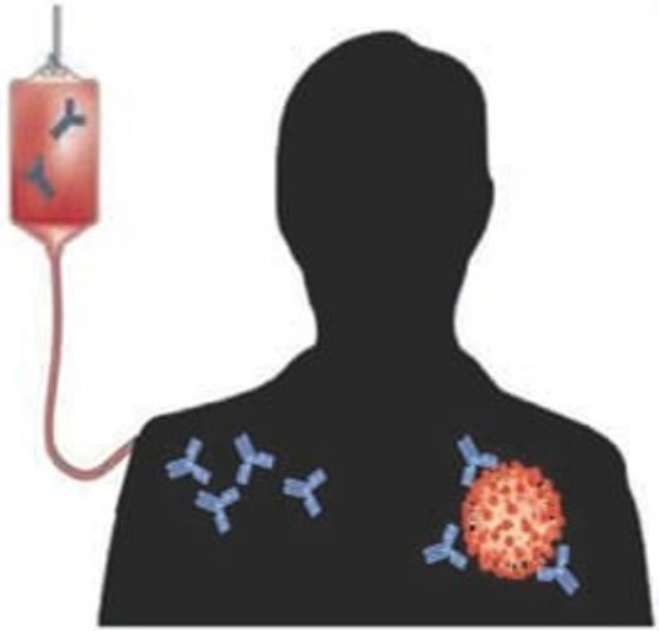
Passive immunity, on the other hand, involves the direct transfer of pre-formed antibodies, acquired either naturally (e.g., from mother to child) or artificially (e.g., through immunoglobulin administration), providing immediate but short-lived protection without immune memory development.

Active Immunity VS Passive Immunity

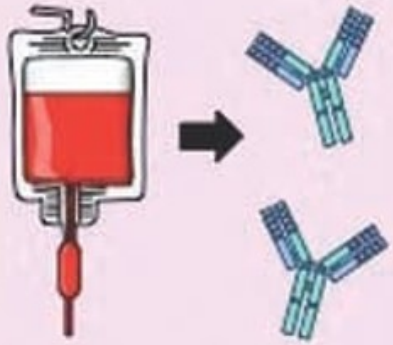
Natural	Artificial	Natural	Artificial
			
Infection	Vaccination	Maternal antibodies	Monoclonal antibodies

Active immunity	Passive immunity
a. Produced actively by the host's immune system	a. Received passively. No active host participation
b. Induced by infection or by immunogen	b. Readymade antibody transferred
c. Durable effective protection	c. Transient, less effective
d. Immunity effective only after lag period	d. Immediate immunity
e. Immunological memory present	e. No immunological memory
f. Booster effect on subsequent dose	f. Subsequent dose less effective
g. Negative phase may occur	g. No negative phase
h. Not applicable in the immunodeficient	h. Applicable in the immunodeficient

Passive immunization



PASSIVE IMMUNITY

Natural	Artificial
	
Maternal antibodies	Monoclonal antibodies

Natural Passive Immunity

Natural passive immunity involves the transfer of maternal antibodies from mother to child, offering temporary protection against diseases early in life.

Maternal antibodies are primarily transmitted through the placenta during pregnancy, where they cross from the mother's bloodstream into the fetal circulation.

Breastfeeding further contributes to natural passive immunity as it supplies additional maternal antibodies and immune factors through breast milk, bolstering the infant's immune defenses.

Natural Passive Immunity

Colostrum is a vital component to the raising of nearly all mammalian newborns. Colostrum contains multiple immunoglobulins (Ig; IgA, IgM, IgG, etc.), with the most abundant Ig in colostrum generally being IgG . It also contains

1. Immunoglobulin A (an antibody).
2. Lactoferrin (a protein that helps prevent infection).
3. Leukocytes (white blood cells).
4. Epidermal growth factor (a protein that stimulates cell growth).

It gets its color from carotenoids (an antioxidant) and vitamin A. Vitamin A plays a vital role in baby's vision, skin and immune system. Colostrum is rich in magnesium, which supports baby's heart and bones, and copper and zinc, which also support immunity.

Concentration of immunoglobulins present In bovine colostrum vs Mature milk

Component	Bovine colostrum	Mature milk
Immunoglobulins		
IgG1 (g/L)	34.0–87.0	0.31–0.40
IgG2 (g/L)	1.6–6.0	0.03–0.08
IgA (g/L)	3.2–6.2	0.04–0.06
IgM (g/L)	3.7–6.1	0.03–0.06

Ref: Playford RJ, Weiser MJ. Bovine Colostrum: Its Constituents and Uses. Nutrients. 2021 Jan 18;13(1):265

Artificial Passive Immunity

Artificial passive immunity employs pre-formed antibodies, mainly immunoglobulins such as IgG, for immediate but brief protection against specific pathogens or toxins.

These antibodies are derived from individuals with pre-existing immunity and are administered to recipients via injections or intravenous infusions.

However, artificial passive immunity does not impart long-term immunity or immune memory, making it suitable for acute situations or individuals incapable of mounting their immune response.

History of Immunoglobulins

The discovery of immunoglobulins marked a significant breakthrough in the field of immunology, shedding light on the body's defense mechanisms against infections and diseases.

Emil von Behring, a pioneering immunologist, made groundbreaking contributions in the **late 19th century**. He conducted extensive research on serum therapy, discovering that serum from animals immunized against a specific pathogen could be used to treat or prevent related diseases in humans.

Von Behring's work laid the foundation for our understanding of antibodies, now known as immunoglobulins, and opened the door to the development of vaccines and the field of immunotherapy, revolutionizing our ability to combat infectious diseases.

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The Nobel Prize in Physiology or Medicine 1901

Emil von Behring

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Article

Emil von Behring: The Founder of Serum Therapy

Based on an exhibition at Marburg Castle
arranged and documented by Kornelia Grundmann*

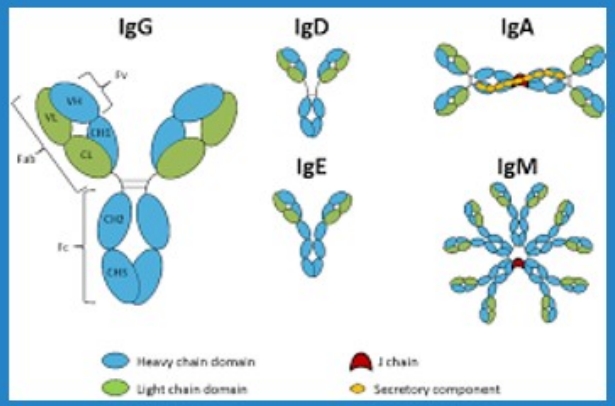
Emil von Behring's research

Emil von Behring's serum therapy, developed in the late 19th century, hinged on the extraction of specific antibodies from animals immunized against pathogens.

His groundbreaking experiments involved demonstrating that these antibodies, when transferred to others, provided immunity against related diseases.

Von Behring's work laid the foundation for modern immunotherapy and vaccines by highlighting the pivotal role of antibodies in immune defenses.

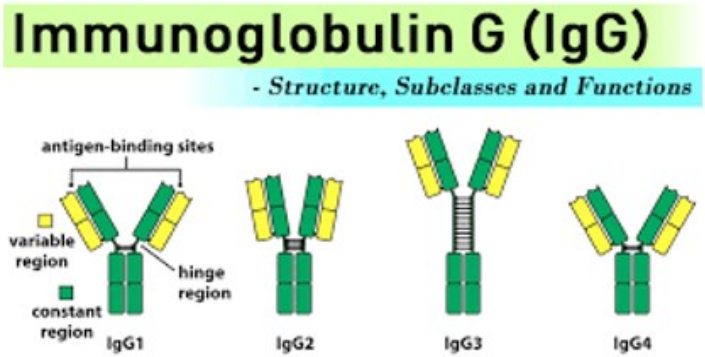
Classes of Immunoglobulins



Immunoglobulins, or antibodies, encompass five distinct classes, namely IgG, IgM, IgA, IgD, and IgE, each tailored for specific immune functions.

IgG, the most prevalent class, offers long-term immunity by neutralizing pathogens and toxins. IgM acts as the initial responder to infections, while IgA plays a pivotal role in mucosal protection.

IgD's precise function is less understood, whereas IgE is primarily involved in allergic responses and defense against parasites. These immunoglobulin classes collectively orchestrate the body's immune responses against a wide array of threats.



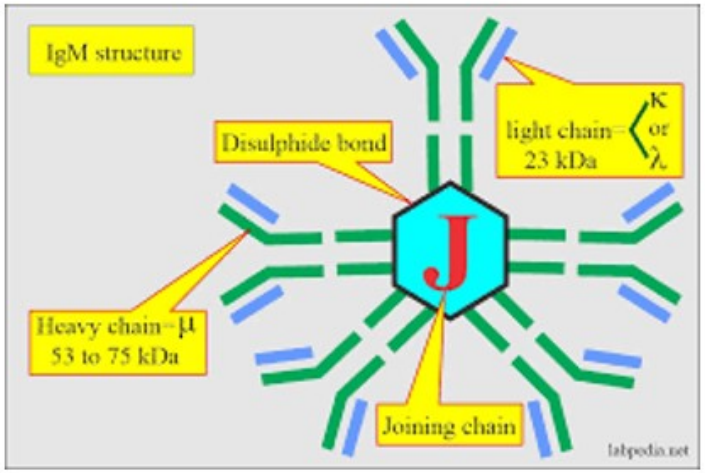
IgG Antibodies

IgG antibodies, belonging to the immunoglobulin class gamma, are pivotal components of the adaptive immune system, recognized for their specificity in targeting a diverse range of pathogens through their antigen-binding sites.

Their role in passive immunity is significant, as IgG antibodies can traverse the placental barrier, conferring immediate protection to newborns against maternal antibody-recognized pathogens.

Furthermore, IgG antibodies provide long-lasting immunity, as they persist in the bloodstream, facilitating memory responses and the rapid mobilization of defenses upon re-exposure to previously encountered pathogens.

IgM Antibodies



IgM antibodies, classified as pentameric immunoglobulins, are distinguished by their large molecular structure and prominent role as the primary antibodies produced during the initial immune response to pathogens.

Their significance lies in their ability to quickly recognize and bind to a wide range of antigens, making them the first responders to infections, aiding in the agglutination of pathogens, and activating the complement system to enhance immune responses.

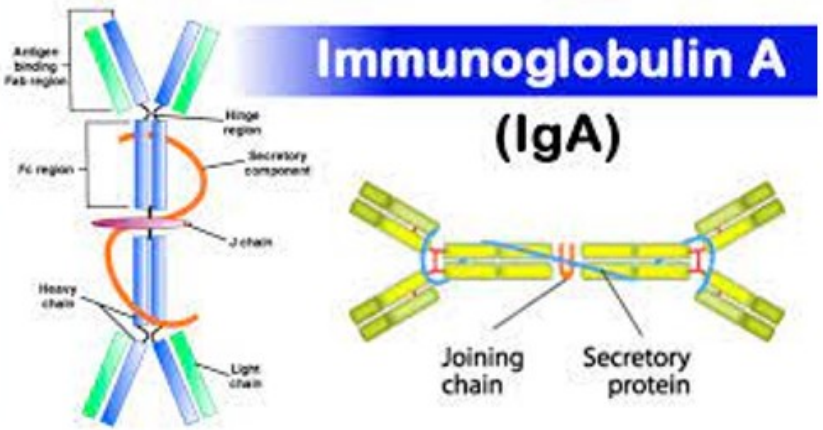
IgM antibodies are critical in orchestrating the innate and adaptive immune systems' early actions, contributing to the body's swift and coordinated defense against invading pathogens.

IgA Antibodies

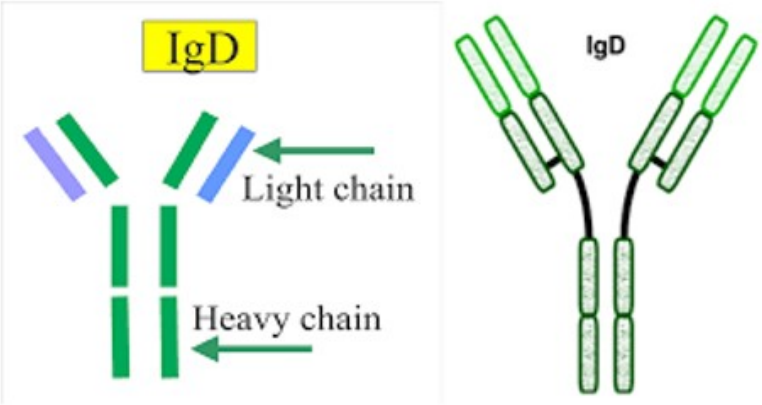
IgA antibodies, classified under the immunoglobulin A class, are pivotal components of the adaptive immune system, primarily responsible for safeguarding mucosal surfaces, including those in the respiratory, gastrointestinal, and genitourinary tracts.

Their importance in mucosal immunity stems from their ability to bind to pathogens and antigens, thus preventing their attachment to mucosal cells and impeding their entry into the body, thereby reducing the risk of infections at these critical sites.

IgA antibodies contribute significantly to the first line of defense against various pathogens and environmental threats, showcasing their essential role in preserving mucosal integrity and overall immune health.



IgD Antibodies

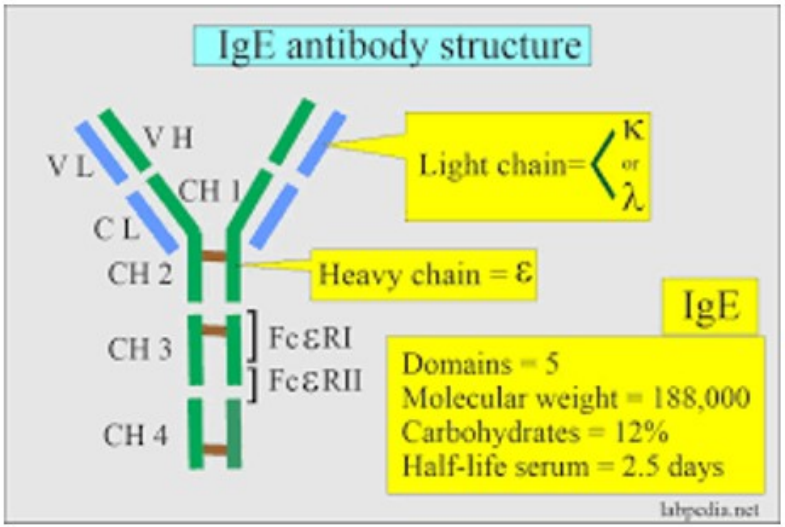


IgD antibodies, categorized as immunoglobulin D, constitute a less understood class of immunoglobulins within the adaptive immune system.

These antibodies are predominantly found on the surface of mature B cells, where they function as antigen receptors, playing a role in the activation and differentiation of B cells during the early stages of immune response initiation.

While the exact functions of IgD antibodies are still under investigation, their presence on B cell surfaces is believed to be vital in orchestrating immune responses by aiding in antigen recognition and subsequent immune reaction activation.

IgE Antibodies



IgE antibodies, classified as immunoglobulin E, represent a specialized class of antibodies known for their unique involvement in immune hypersensitivity reactions, particularly type I allergies.

Their primary function is to bind to allergens and activate mast cells and basophils, initiating the release of inflammatory mediators, such as histamines, that underlie the characteristic symptoms of allergies.

IgE antibodies also demonstrate significance in immune responses against parasitic infections, where they facilitate the activation of immune cells to target and eliminate parasites, contributing to the host's defense against these pathogens.

Clinical Uses of Immunoglobulins

Immunoglobulins have diverse medical applications, notably in immunoglobulin therapy, addressing immunodeficiency disorders, autoimmune diseases, and neurological conditions.

Immunoglobulin therapy encompasses primary immunodeficiencies and autoimmune disorders like rheumatoid arthritis, harnessing immunomodulatory effects to ameliorate symptoms.

In neurological diseases such as Guillain-Barré syndrome, Myasthenia crisis immunoglobulin therapy targets neuroinflammation, demonstrating immunomodulatory benefits that contribute to therapeutic efficacy.

Immunoglobulin Therapy

Immunoglobulin therapy entails the controlled administration of purified immunoglobulins, derived from human plasma or recombinant sources, for immune modulation in medical conditions.

Administered intravenously or subcutaneously, dosages are customized to specific diseases. Immunoglobulin therapy is therapeutically effective, bolstering passive immunity, modulating autoimmunity, and mitigating symptoms in a range of disorders, tailored to each condition and individual response.

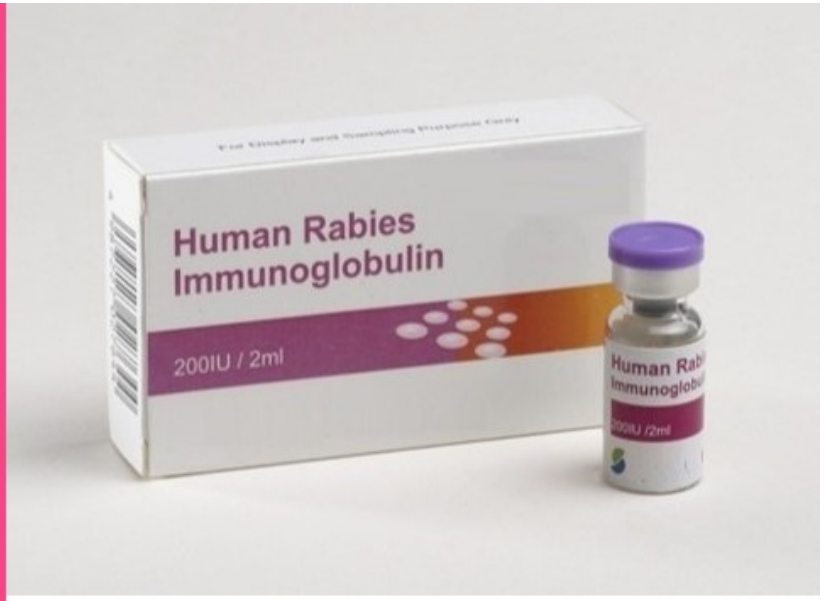
Its clinical impact is particularly notable in immunodeficiencies, autoimmune diseases like myasthenia gravis ,G-B Syndrone, and select neurological conditions such as chronic inflammatory demyelinating polyneuropathy, providing immune support, autoimmunity control, or immunomodulation to enhance patient outcomes.

Passive Immunity in Disease Prevention

Passive immunity is used to prevent diseases by administering pre-formed antibodies when the body's own immune response is insufficient or slow.

For example, in cases of potential exposure to hepatitis or rabies, specific immunoglobulins are administered to swiftly neutralize the pathogens and prevent infection.

This approach is crucial for immediate protection, particularly in situations where timely immune responses are critical, such as post-exposure prophylaxis for rabies or high-risk hepatitis exposure.

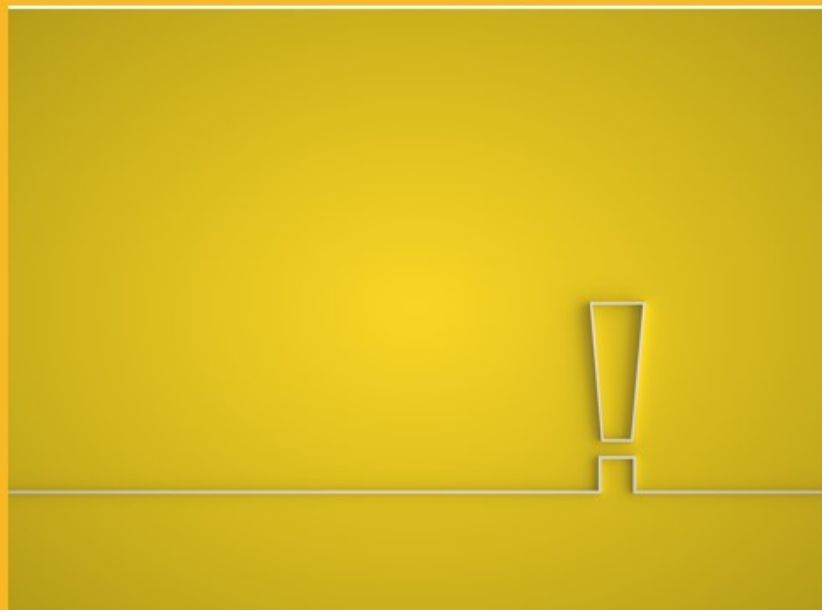


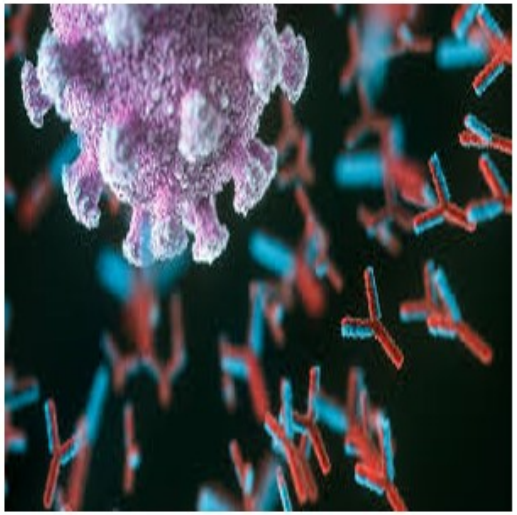
Limitations of Passive Immunity

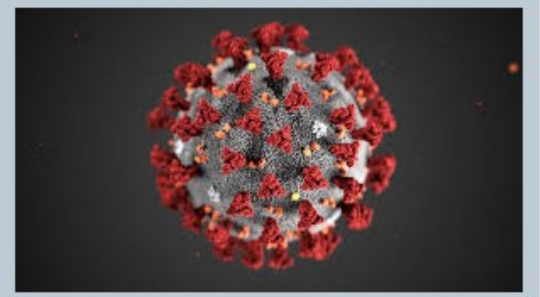
Passive immunity's foremost limitation lies in its temporary nature, stemming from the gradual decline of administered antibodies within the recipient's system.

The transience of this immunity necessitates recurrent antibody administrations for sustained protection, presenting logistical and economic challenges for long-term disease management.

Furthermore, passive immunity does not promote the recipient's endogenous immune response, hence lacks the capacity to establish lasting immunological memory, thus restricting its effectiveness against future exposures.



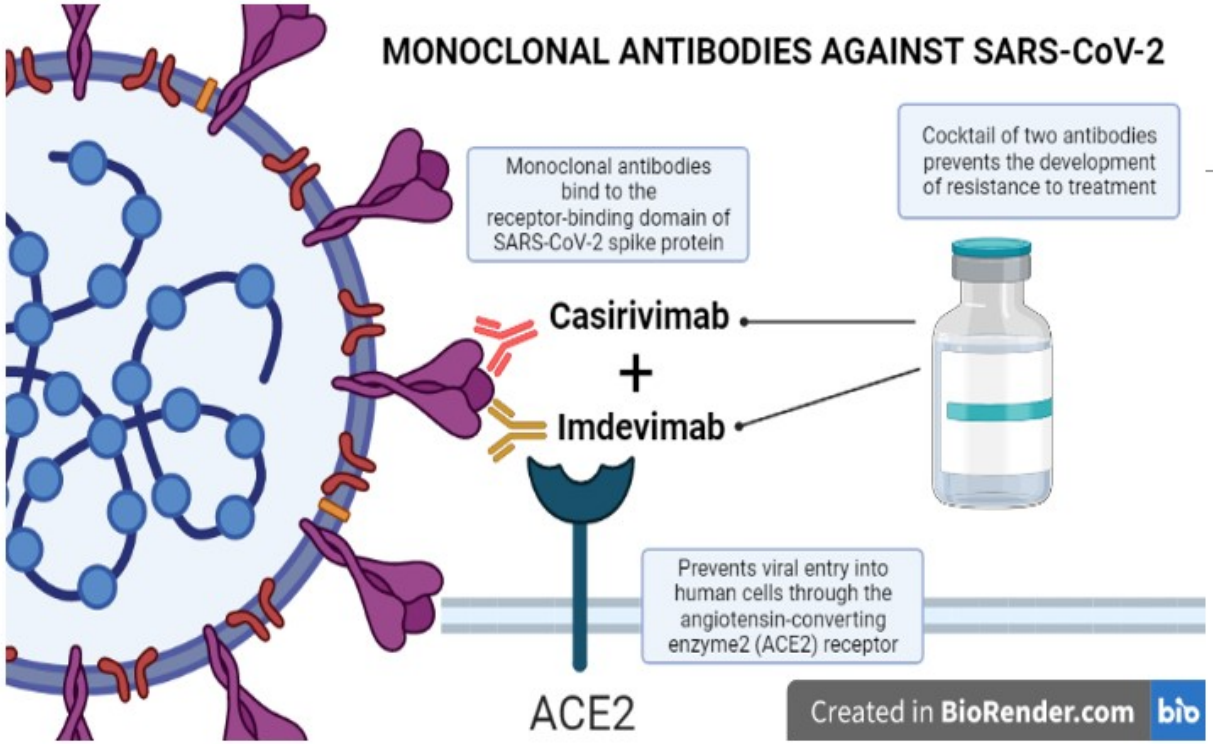




Future Developments

Current research in passive immunity and immunoglobulin therapy centers on advancements in antibody production techniques, including monoclonal antibodies and extended half-life engineered antibodies, aiming to improve treatment safety and effectiveness.

The neutralizing monoclonal antibodies (mAbs) given emergency use authorization for treatment of COVID-19 were derived from either convalescent patients or humanized mice exposed to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) antigens.



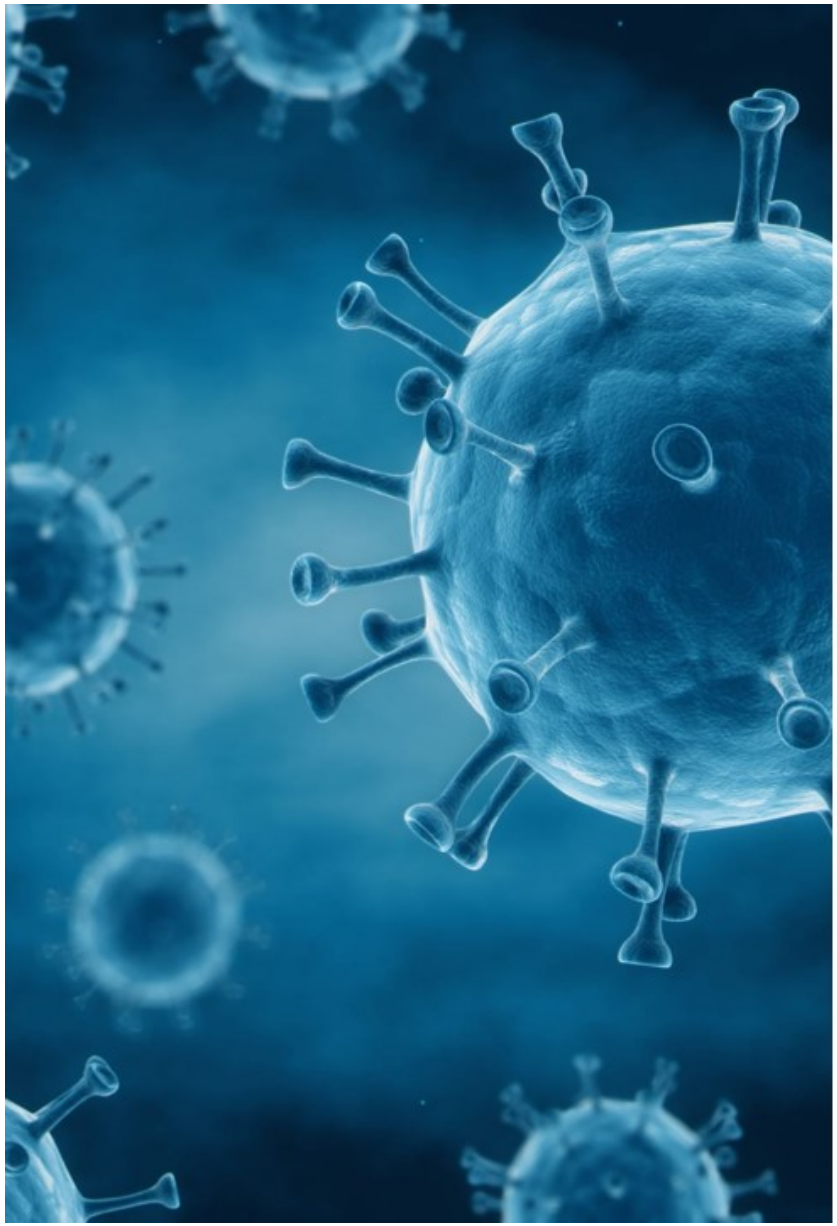
In the United States, three anti-severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) mAb therapies have been granted emergency use authorization (EUA) for treatment of non-hospitalized patients with mild-to-moderate COVID-19 —

these are

1. bamlanivimab as a monotherapy, and

2. bamlanivimab together with etesevimab

3. casirivimab with imdevimab as a combination therapy



Conclusion

Passive immunity, facilitated by administered antibodies like immunoglobulins, delivers immediate protection against diseases, a key takeaway from this presentation.

Understanding the nuances of passive immunity and immunoglobulins is vital, as it empowers us to respond rapidly and effectively to health threats, ranging from safeguarding vulnerable individuals to managing post-exposure prophylaxis.

Mastery of these mechanisms and applications underscores their central role in reinforcing our immune defenses, underscoring their importance in public health.

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