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Acquired Immunity

Lec 4

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2022-2023

2. Adaptive (specific) (acquired) immunity

Adaptive immunity refers to antigen-specific immune response. The adaptive immune response is **more complex than the innate immune response.**

Adaptive immune response **takes days or even weeks** to become established much longer than the innate response; however, adaptive immunity :

- Can adapt to defend against any specific invader inside or outside of the cell (Effective against both intra- and extracellular pathogens)
- Important when innate immunity cannot defend against the attack
- Provides 'Immune Memory'

Properties of Acquired Immunity

- **Mediators-** ***T cells & B cells*** are the chief mediators of acquired immunity. Others include-
  - Classical complement pathway
  - Antigen presenting cells
  - Cytokines (IL-2, IL-4, IL-5)
- **Response occurs in days -** It requires the activation of T and B cells against the microbial antigens.
- **Requires prior microbial exposure-** Acquired immunity develops only after the exposure to the microbes.

Properties of Acquired Immunity

- **Specific-**Acquired immunity is highly specific; directed against specific antigens that are unique to the microbes.

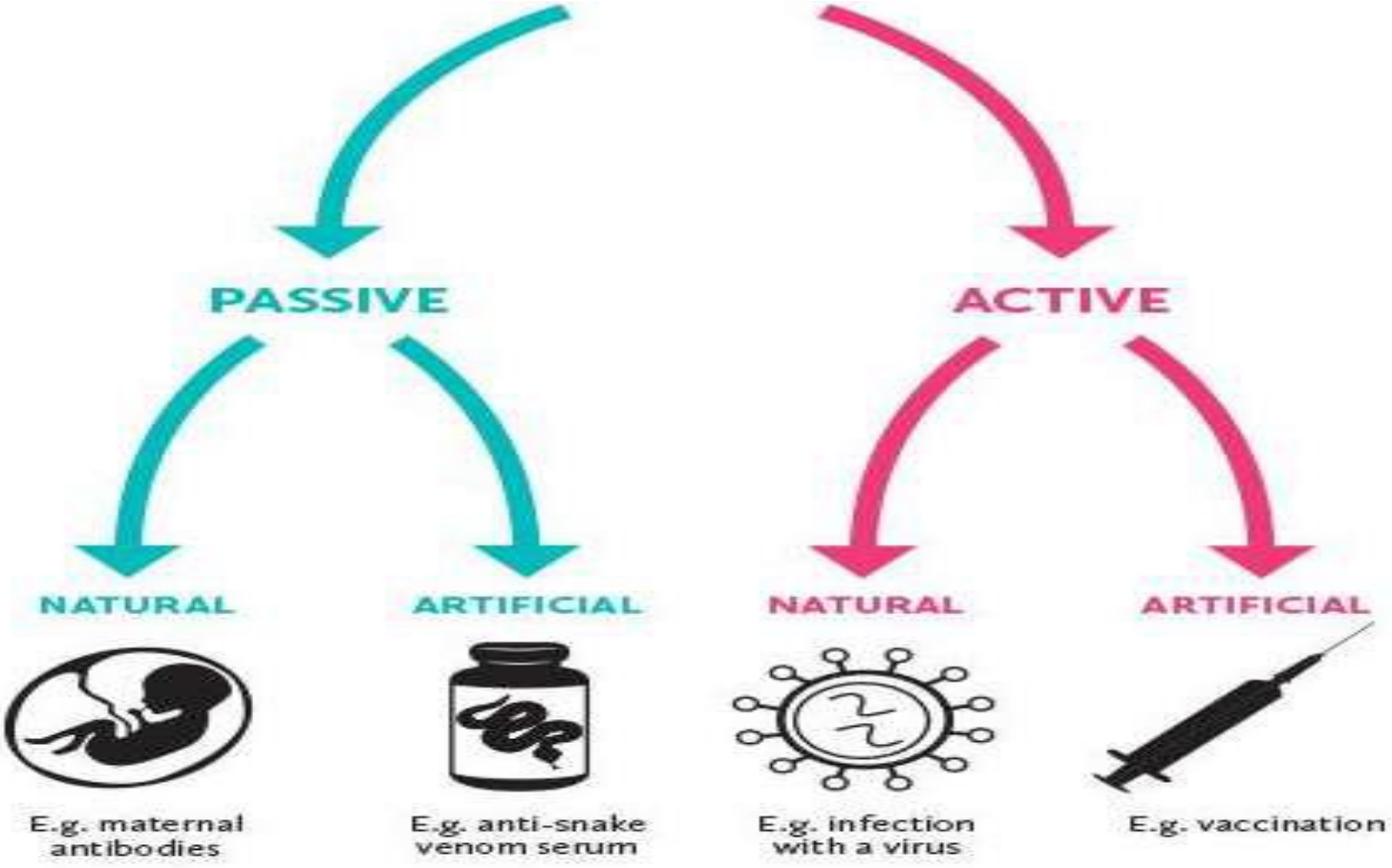
- **Memory present-** A proportion of T and B cells become memory cells following primary contact of the microbe, which play an important role when the microbe is encountered subsequently.

- **Diversity is wide-** Acquired immunity though takes time to develop is active against a wide range of repertoire of antigens.

- **Host cell receptors** of acquired immunity are specific for particular microbial antigen-
  - Examples include-T cell receptors and B cell immunoglobulin receptors

Types of Acquired immunity

- Active and passive immunity
- Artificial and natural immunity


PASSIVE
ACTIVE
NATURAL
ARTIFICIAL
NATURAL
ARTIFICIAL
E.g. maternal antibodies
E.g. anti-snake venom serum
E.g. infection with a virus
E.g. vaccination

Differences between active and passive immunity

Active immunity	Passive immunity
Produced actively by host immune system	Immunoglobulins received passively
Induced by • Infection (natural) • Vaccination (artificial)	Acquired by- • Mother to fetus IgG transfer (natural) • Ready made antibody transfer (artificial)
Long lasting	Lasts for short time
Lag period present	No Lag period
Memory present	No Memory
Booster doses-useful	Subsequent doses-Less effective
Negative phase may occur	No Negative phase
In immunodeficiency individuals not useful	Useful in immunodeficient individuals

Active Immunity

- Active immunity is the resistance developed by an individual towards an antigenic stimulus.
- Active immunity may be induced naturally or artificially:
  - *Natural active immunity* (e.g. measles virus infection)
  - *Artificial active immunity* (e.g. measles vaccine).

Active Immunity

- **Long-lasting**- Active immunity usually lasts for longer periods but the duration varies depending on the type of pathogen.
  - Last life long- e.g. following certain viral infections such as chicken pox, measles, small pox, mumps and rubella.
  - Last short- e.g. following influenza infection.

Active Immunity

- Premunition or concomitant immunity – Immunity may last as long as the microbe is present. Once the disease is cured, the patient becomes susceptible to the microbe again (*Spirochaetes* and *Plasmodium).*

- Active immunity may not be protective at all- e.g. for *Haemophilus ducreyi*, the patient may develop genital lesions following reinfection even while the original infection is active.

Artificial Active Immunity

- Resistance induced by vaccines
- Bacterial vaccines
  - Live : BCG vaccine
  - Killed: Cholera vaccine
  - Subunit : Typhoid Vi antigen
  - Bacterial products: Tetanus toxoid
- Viral vaccines
  - Live : OPV-Sabin
  - Killed : IPV – Salk
  - Subunit : Hepatitis B Vaccine

Vaccines

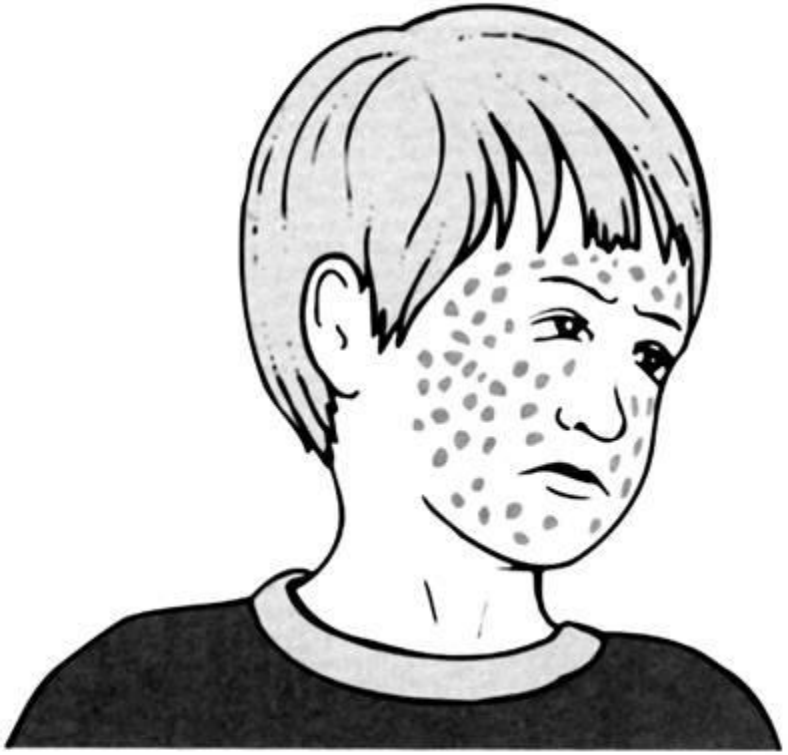
KILLED VACCINES

- No infective stage
- Less immunogenic
- Repeated doses needed
  – Primary dose
  – Booster dose
- Oral doses not effective
- Parenteral doses given with adjuvant to increase humoral immunity

LIVE VACCINES

- Infection without disease
- Immunity lasts for several years
- Booster doses MAY BE needed
- Can be given orally or parenterally

Measles attacks & *immunological memory*



In a first attack of measles, adaptive immunity is too slow to prevent the virus growing and causing symptoms

In a second attack, an antibody response is made so rapidly that the virus is disposed of before symptoms appear

"Immunological memory & vaccination

- **Natural infections:**

  1st infection → memory → 2nd infection

  slow response — *fast response*

  pathogens multiply — *pathogens disposed*

  Symptoms/disease — *no disease*

- **Vaccination →** **memory →** **nature infections**

  no disease — ***fast response***

  pathogens disposed

  no disease

Primary immune response

- When the antigenic exposure occurs for the first time, the following events take place-
  - *Latent or lag period* - Active immunity develops which corresponds to the time required for the host's immune apparatus to become active.
  - *Effector cells*-Majority of activated T and B cells against the antigenic stimulus become effector T and B cells
    - Effector T cells such as helper T cells and cytotoxic T cells
    - Effector B cells include plasma cells

Passive Immunity

- No infection
- Readymade antibodies are administered
- No latent period
- No negative phase
- Immediate protection

Types of Passive Acquired Immunity

- Resistance transferred from mother to baby via placenta
- Breast milk – colostrum
- Active immunization of mother provides passive immunity to infants
- Eg. Tetanus toxoid during pregnancy

Types of passive acquired immunity

- Resistance transferred by administration of antibodies
- Hyper immune sera
- Convalescent sera
- Pooled human ɣ globulin
- Used for prophylaxis and therapy

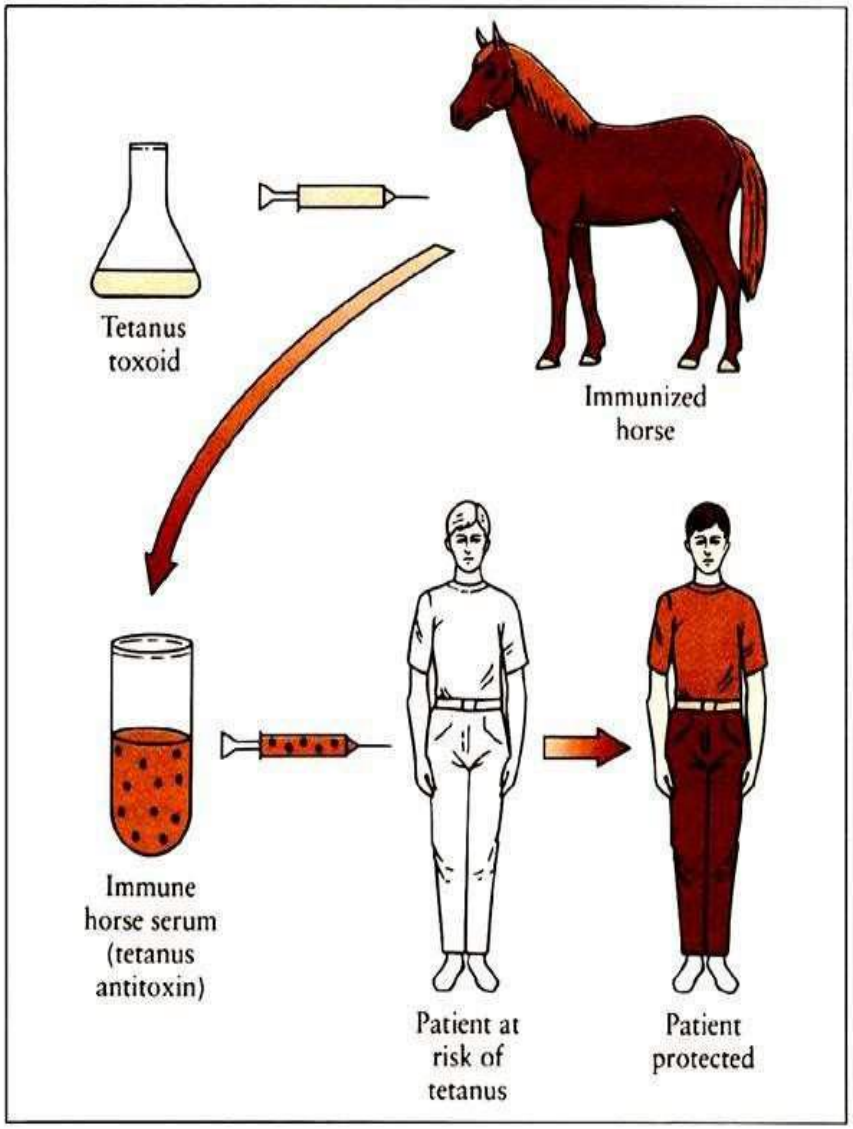
Hyperimmune sera

- Anti-tetanus serum (ATS)
- Prepared from hyperimmunized horses
- Temporary protection

❖Disadvantages

- Hypersensitivity
- Immune elimination
- In use

– Hyperimmune globulin of human origin



Convalescent sera

- Sera of patients recovering from disease
- Contain high levels of antibody specific to the disease
- Use – Viral infections like Hepatitis A

Pooled human Ɣ globulin

- Ɣ globulin from pooled sera of healthy adults
- Has antibodies to all pathogens prevalent in the area
- Use – Rx of patients with immunodeficiencies

Indications for Passive Immunization

- Immediate and temporary protection of a person at risk of developing infection
- To arrest overactive active immunity

Eg. Rh incompatibility

Combined Immunization

- Combination of active and passive methods
- Passive immunization for immediate protection
- Followed by complete schedule of vaccination

Adoptive Immunity

- Special type of immunization
- Injection of immunologically competent lymphocytes ⟹ ***TRANSFER FACTOR***
- Tried in treatment of Lepromatous Leprosy

Local Immunity

- Besredka
- Treatment of infections in a localized area
- Polio –

–Systemic immunity by Inactivated Polio Vaccine (IPV)

- Does not prevent multiplication of virus in the gut

– This is achieved by Oral polio vaccine (OPV)

- Influenza

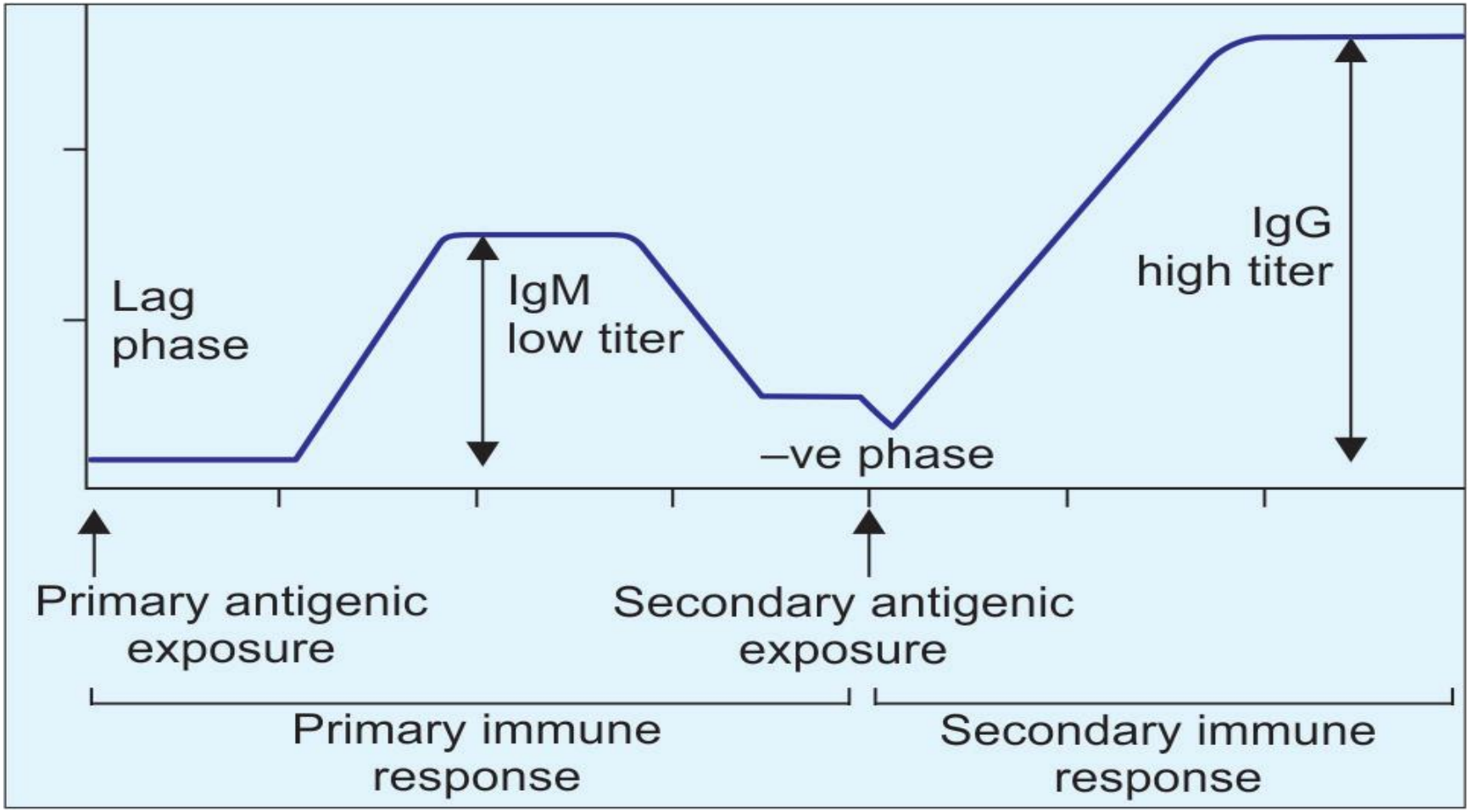
– Killed vaccine brings about a humoral response

- Not enough to prevent infection
- Intra nasal live virus injection/ natural infection provides local immunity

Primary immune response

- *Memory cells*- A minor proportion of stimulated T and B cells become memory cells, which are the key cells for secondary immune response.
- *Antibody surge*
  - Activated B cells produce antibodies (mainly IgM type).
  - Antibodies appear in the serum in slow & sluggish manner; reach peak, maintain the level for a while and then fall down.
  - Finally, a low titer of baseline antibodies may be maintained in the serum.

Acquired Immunity



Secondary immune response

- When the same antigenic exposure occurs subsequently, the events which take place are as follows:
  - *Latent period*
  - *Negative phase*
  - *Antibody surge*

Passive Immunity

- Passive immunity is defined as the resistance that is transferred passively to a host in a 'readymade' form without active participation of the host's immune system.
- Passive immunity can also be induced naturally or artificially.
  - *Natural passive immunity* involves the IgG antibody transfer from mother to fetus across the placenta.
  - *Artificial passive immunity* develops following readymade transfer of commercially prepared immunoglobulin

    (e.g. Rabies immunoglobulin)

Role of passive immunity

- Immunodeficient individuals

  (as host's immune apparatus is not effective)
- Post exposure prophylaxis; when an immediate effect is warranted.
- Passive immunity *develops faster*; there is no lag phase or negative phase.
- There is *no immunological memory* as the memory cells are not involved.
- *Booster doses are not effective*

Differences between Primary and Secondary immune response

Primary immune response	Secondary immune response
Immune response against primary antigenic challenge	Immune response against subsequent antigenic challenge
Slow, sluggish (appear late) and short lived	Prompt, powerful & prolonged (long lasting)
Lag period is longer (4-7 days)	Lag period is absent or short (1-3 days)
No negative phase	Negative phase may occur
Antibody produced in low titer & is of IgM type. Antibodies are more specific but less avid	Antibody produced in high titer & is of IgG type Antibodies are less specific but more avid
Antibody producing cells- Naive B cells	Antibody producing cells- Memory B cells
Both T dependent and T independent antigens are processed.	Only T dependent antigens are processed.

Bridges Between Innate and Acquired Immunity

- **Macrophages and dendritic cells**:
  - Belong to innate immune system but as antigen presenting cells, they present the antigenic peptides to T cells.
  - Cytokines secreted from macrophages (interleukin-1) are also involved in T cell activation.
- **ADCC** (antibody dependent cell mediated cytotoxicity):
  - Type of cell mediated immune response (CMI), which involves both innate and adaptive components.
  - Cells of innate immunity such as NK cell, eosinophils, and neutrophils destroy (by cytotoxic effect) the target cells coated with specific antibodies.

Bridges Between Innate And Acquired Immunity

- **Complements** (classical pathway)
  - Part of both innate and adaptive immunity.
  - Destroy the target cells which are coated with specific antibodies.
  - Alternate and mannose binding pathways do not take help of antibodies.
- **Cytokines**
  - Secreted from cells of innate immunity can activate cells of adaptive immunity and vice versa.
  - E.g. IL-1 secreted from macrophage activates helper T cells and interferon-γ secreted by helper T cell can activate macrophage.

Bridges Between Innate And Acquired Immunity

- **Rare classes of lymphocytes** such as γδ T cells , NK-T cells, B-1 cells and Marginal-zone B cells.
  - These cells have many characteristics that place them in the border of innate & acquired immunity.
  - Function in the early defence against microbes as part of innate immunity.
  - Although their receptors are encoded by somatic recombination of genes (similar to that of classical T and B cells), but these receptors have limited diversity.
  - develop a memory phenotype in contrast to the property of innate immunity.

Local (or mucosal) immunity

- Immune response that is active at the mucosal surfaces such as intestinal or respiratory or genitourinary mucosa.
- Mediated by a type of IgA antibody called secretory IgA.
- Local immunity can only be induced by natural infection or by live vaccination (but not by killed vaccines).