Department Of Biotechnology

Acquired or Adaptive Immunity

By
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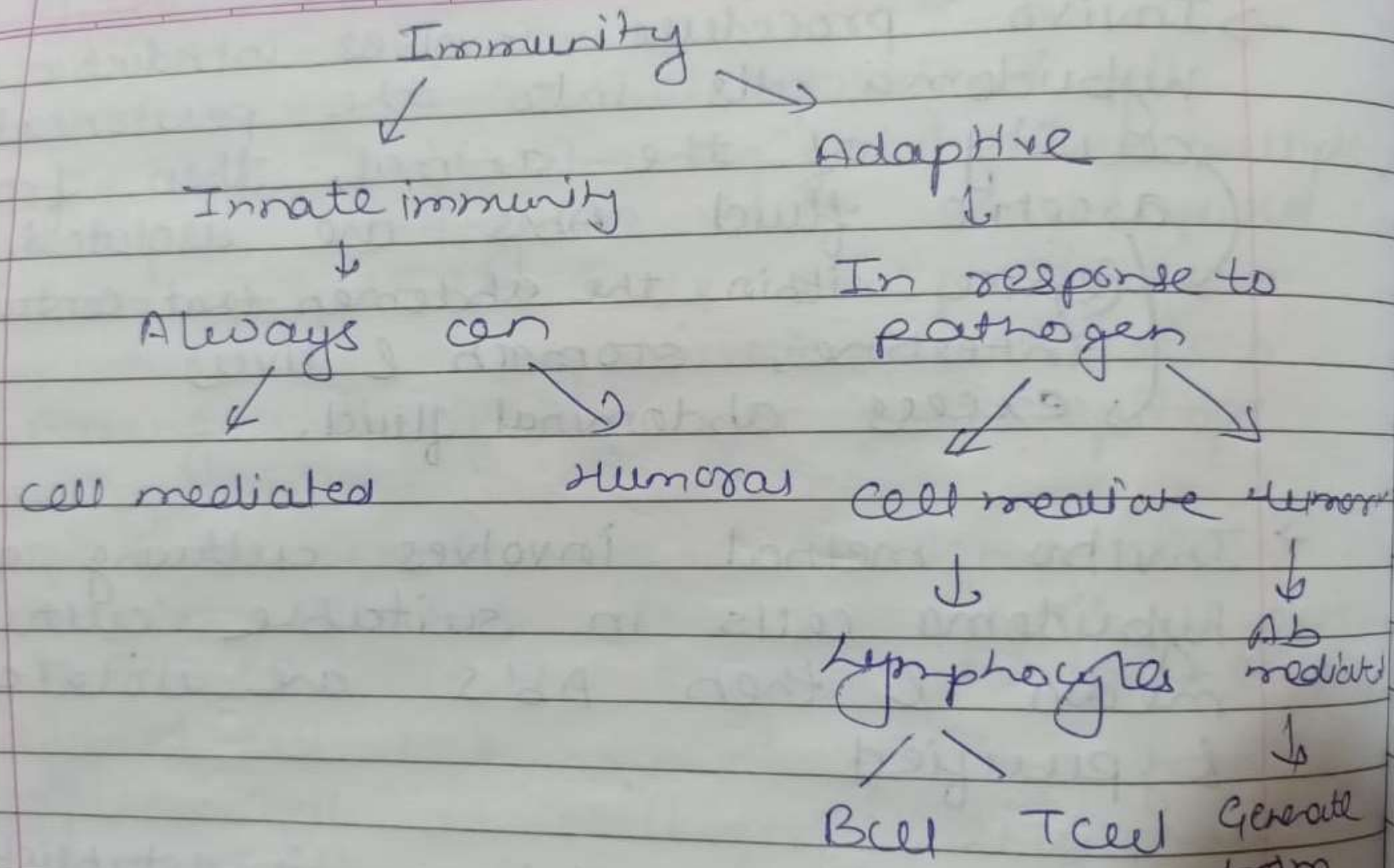
Aquired ~~cells~~ Immunity



Innate immunity further classified

- Main Components of Innate and acquired Immunity that contribute to humoral (antibody-mediated) immunity and cell mediated immunity

	Humoral Immunity	Cell mediated Immunity
Innate	Complement Neutrophil	Macrophages Natural killer cells
Acquired	B cells Antibodies	Helper Tcells Cytotoxic T cells

Adaptive immunity: second line of response

- Based upon resistance acquired during life
  - comes into action after innate immunity fails to get rid of microbe
- Relies on genetic events and cellular growth
- Responds more slowly, over few days

Three major functions

- Recognize nonself
- Respond to nonself
- Remember nonself

What is adaptive immunity ?

Adaptive ('acquired') immune system **

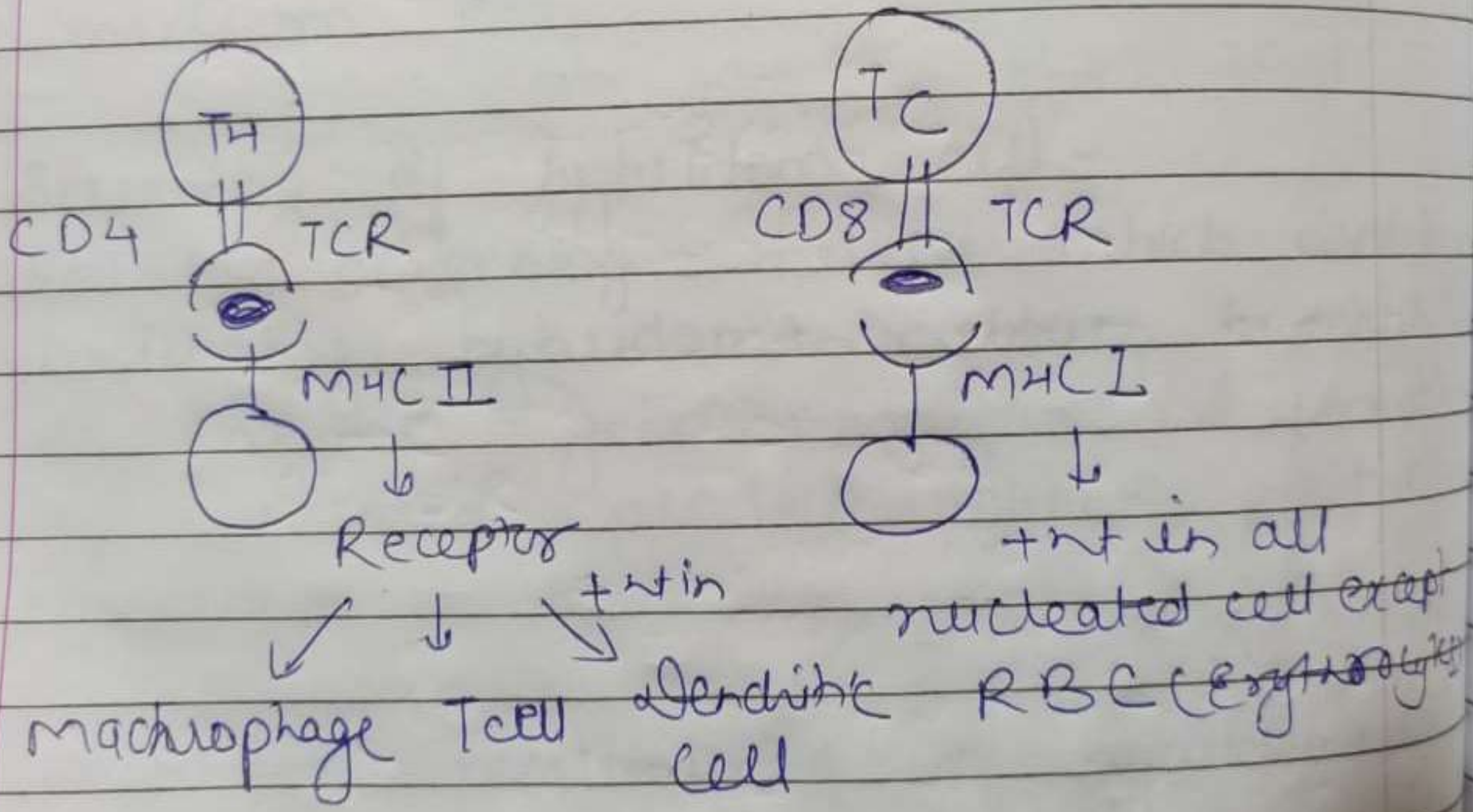
B cells – mature in bone marrow; contribute to antibodies that bind directly with specific antigens; contribute to humoral immunity [b]

T cells – mature in the thymus; express T cell receptors and CD4 or CD8 (not both); contributes to cell-mediated immunity [c]

- T cell receptors only recognise antigens bound to certain receptor molecules (major histocompatibility complex [MHC] class I or II)
- CD4 and CD8 contribute to T cell recognition and activation by binding to either MHCI or MHCII

Highly specific (identifies pathogens and differences in molecular structures) and **slow** (days)

CD4 – Helper T cell OR
CD8 – Cytotoxic T cell



Four Characteristics of Adaptive (Specific) Immunity

- **Discrimination between self and non-self**
  - usually responds selectively to non-self, producing specific responses against the stimulus
- **Diversity**
  - generates enormous diversity of molecules
- **Specificity**
  - can be directed against one specific pathogen or foreign substance among trillions
- **Memory**
  - response to a second exposure to a pathogen is so fast that there is no noticeable pathogenesis

Adaptive

Naturally acquired

Passive

we didn't do anything

↓

Premade

Abs passing from mom to baby throw placenta or breast milk

Active

we did something

↓

infected

↓

Ag's enter the body naturally

↓ infect

body forms Abs

Artificially acquired

Passive

↓

we didn't do anything

↓

Pre-formed made Abs from other patient/lab

↓

Pre formed Abs introduced to your body

↓

Anti serum

Active (vaccine)

↓

we did something

↓

Vaccine (Ags)

↓

a weakened or killed organism

↓

Then the body fought

↓

& develop Abs

Adaptive Immunity

The resistance that an individual acquires during life

Active Immunity

Resistance developed as a result of antigenic stimulus

Natural active immunity

Type of specific immunity a host develops after exposure to foreign substance

Artificial active immunity

(vaccination)

Intentional exposure to a foreign material

Passive Immunity

Resistance transmitted passively in ready made form

Natural passive immunity

Transfer of antibodies, e.g., mother to fetus across

Artificial acquired passive immunity

Preformed antibodies or lymphocytes produced by one host are introduced into another host

Adaptive Immunity

Active immunity	Passive immunity
Produced actively by host immune system	Immunoglobulins received passively
Induced by • clinical, sub-clinical Infection (natural) • Vaccination (artificial) Live, killed, purified antigen vaccine	Acquired by- • Mother to fetus IgG transfer, breast milk, (natural) • Readymade antibody transfer immune serum, immune cells (artificial)
Long lasting	Lasts for short time

Types of Adaptive(Acquired)

Acquired Immunity

Natural immunity
is acquired through the normal life experiences of a human and is not induced through medical means.

Artificial immunity
is that produced purposefully through medical procedures (also called immunization).

Active immunity
is the consequence of a person developing his or her own immune response to a microbe.

Passive immunity
is the consequence of one person receiving preformed immunity made by another person.

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is the consequence of a person developing his or her own immune response to a microbe.

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Infection

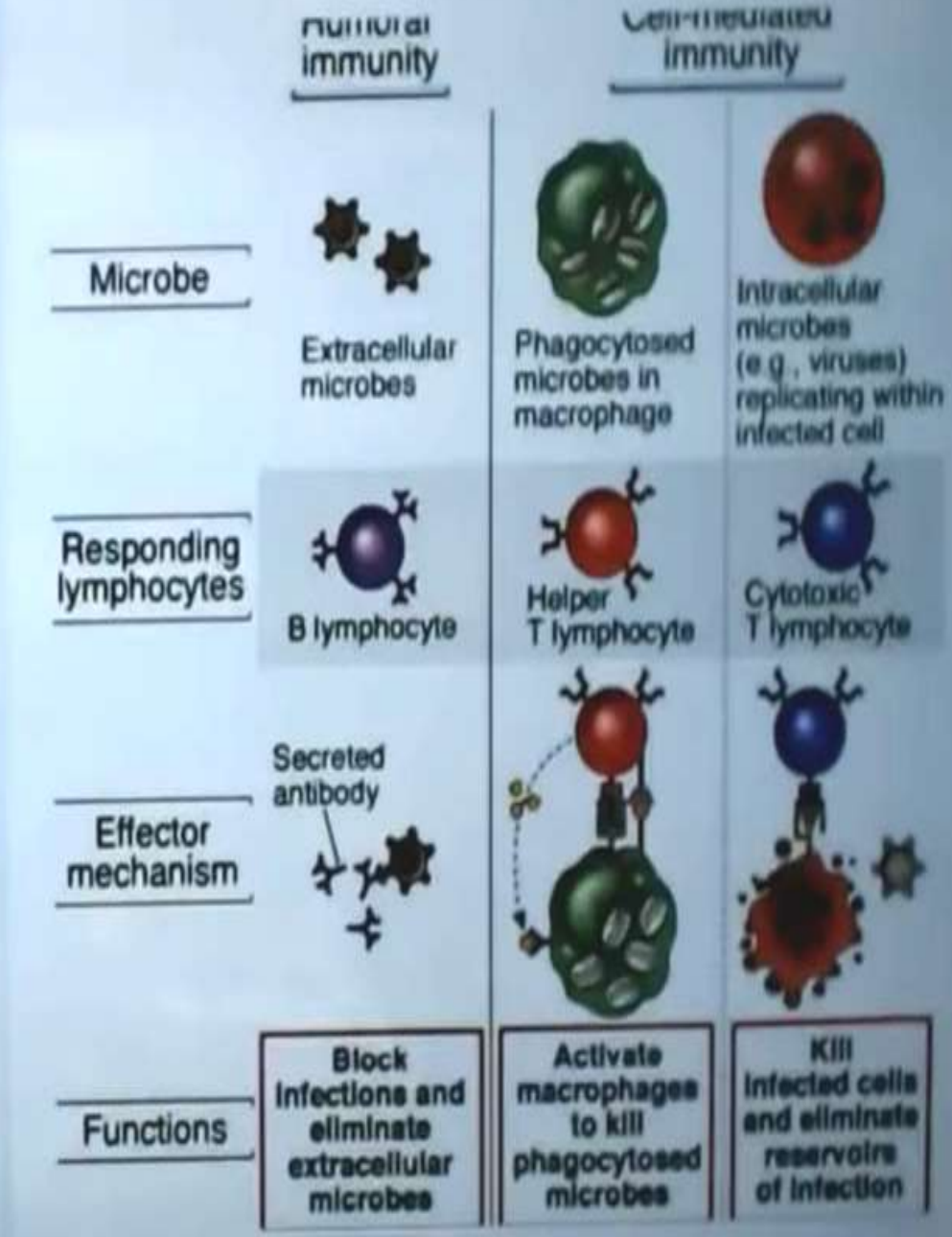
Maternal antibody

Vaccination

Immune globulin therapy

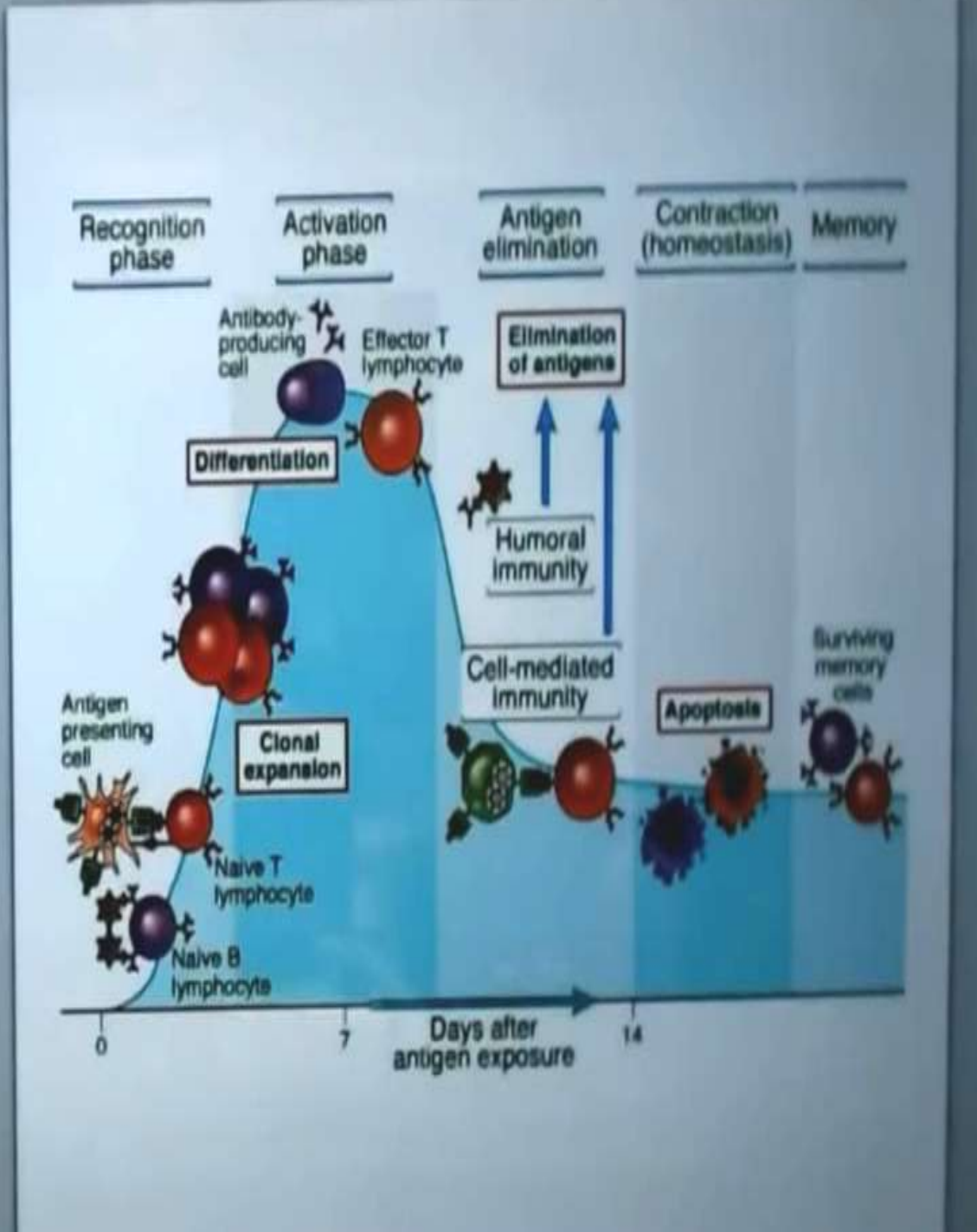
Type of adaptive immunity

- Different types of immune responses are mediated by different classes of lymphocytes and defend against different types of microbes



Phases of adaptive immune response

- Need for proliferation and differentiation results in delay (typically 4-7 days) in the adaptive immune response



↓

Host expose to Ag

↓

engulf by macrophage
→ Bcell
→ DC

↓

degrade in small p

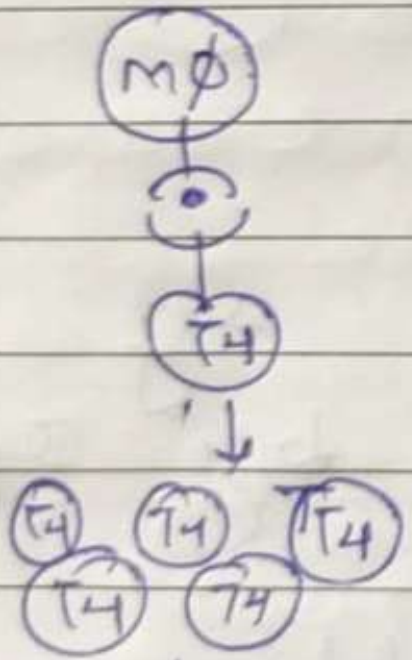
↓

present by APC

↓

Recognige by naive

↓



Release signalling molecule

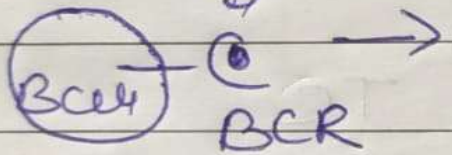
Naive T cells propagation (clonal expension) ← → First time

↓

that activate B cells

↓ naive B cell

IgM



→ different receptor bind to Ab

↓

which Ab bind more accurately with Ag

↓

prepare that type of Ab

↓ Y Y Y Y

convert himself to plasma cell

② Activation phase

↓

Plasma cell → produce Ab's

Effector T cell + B cell

↓

③ Ag elimination → Opsonisation
→ complement fixation
→ direct lysis

↓

Humoral Immunity & cell mediated cells

↓ ↓

NK cells Macrophages

↓

kill

Ag level ↓ drop

Temp change, CRP → C reactive protein level high ← infection

④ Homeostasis

↓

Reach the previous situation

↓

After killing pathogen

Apoptosis — kill excess cells by programme death

↓

that fight with pathogen

protein level high ← infection

④ Homeostasis

↓

Reach the previous situation

↓

After killing pathogen

Apoptosis — kill excess cells by programme death ↓ that fight with pathogen

⑤ ~~Memory~~ → some B cell & T cell left for memory

↓

when again same Ag come

↓

fight ~~with~~ fast

Adaptive immunity: mechanisms

- Cell-mediated immune response (CMIR)
  - Mediated by T cells via:
    - Direct lysis of target (infected) cells
    - Production of cytokines that activate infected cells to kill pathogens
  - Eliminate intracellular microbes that survive within phagocytes or other infected cells
- Humoral immune response (HIR)
  - Mediated by antibodies produced by B cells
    - Antibodies bind to whole or fractions of antigens outside cells
  - Eliminate extra-cellular microbes and their toxins

1. Cell mediated response

- **Primary response**

– production of specific clones of effector T cells and memory clones

– develops in several days

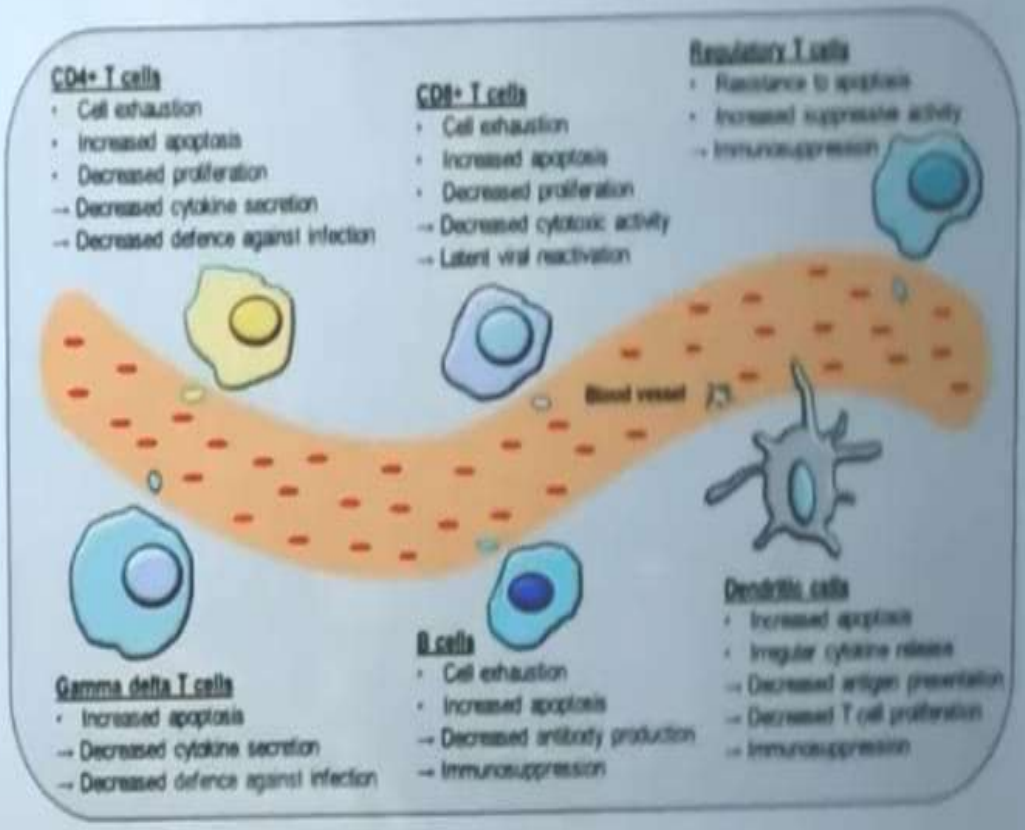
– does not limit the infection

- **Secondary response**

– more pronounced, faster

– more effective at limiting the infection

- **Example** - cytotoxic reactions against intracellular parasites, delayed hypersensitivity (e.g., Tuberculin test) and allograft rejection



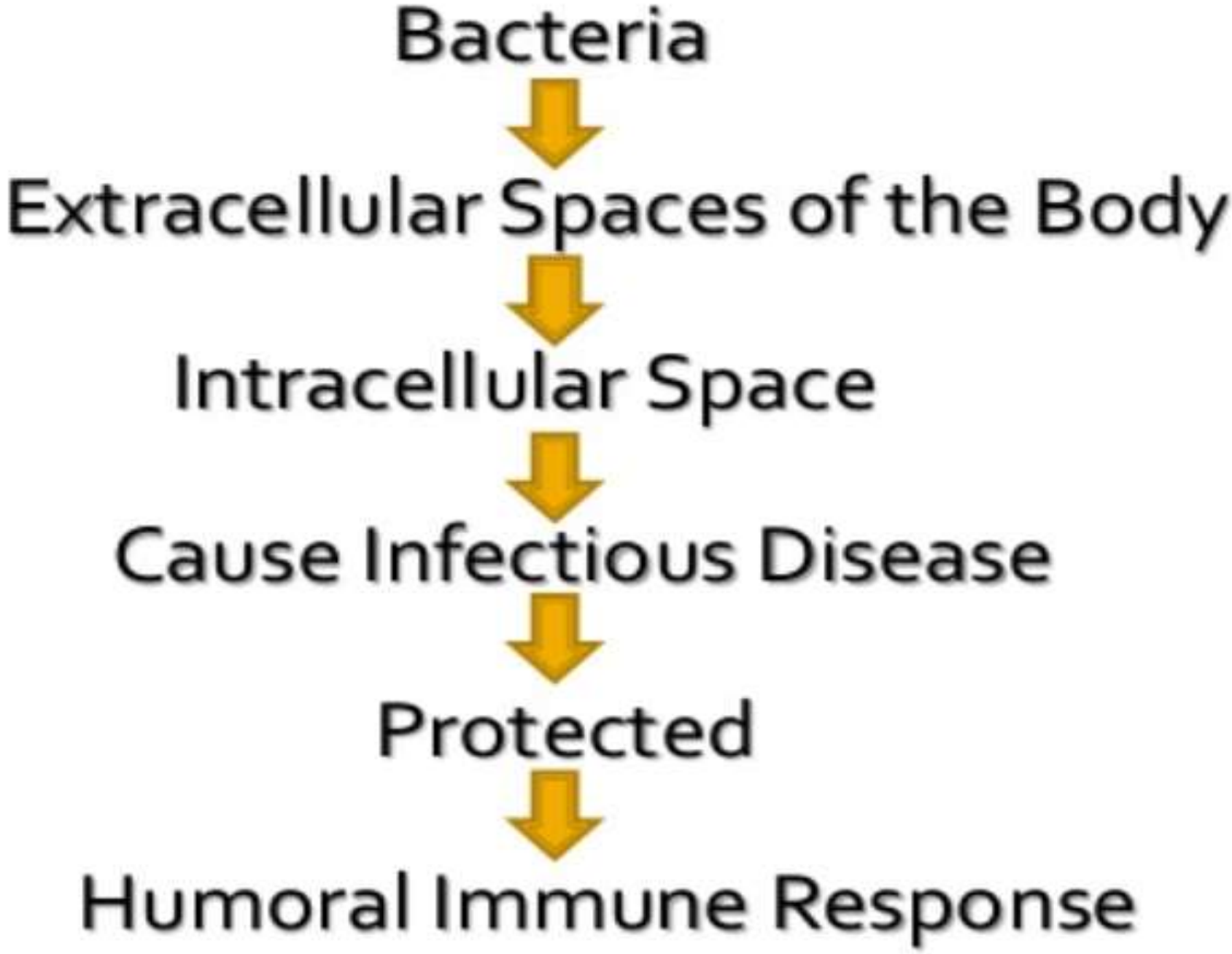
HUMORAL IMMUNITY

• Humoral immunity is conferred by body (fluids) humors specifically by Igs secreted by terminally differentiated B cells (i.e plasma cells).
• If a foreign agent enters in to the body, immune system responds in different ways to get rid of it from the body.
• Response is not the same for all foreign agents. Response depends on the type of antigen or foreign substances which entered the body.
• Responses of immune system to any foreign agent are broadly classified in two main types one is humoral mediated response and the other is cell mediated.

• The destruction of antigens by producing antibodies is called antibody mediated immune response.

• Antibodies react with antigens (pathogens) present outside the cells. They cannot kill the pathogens present outside the cell.

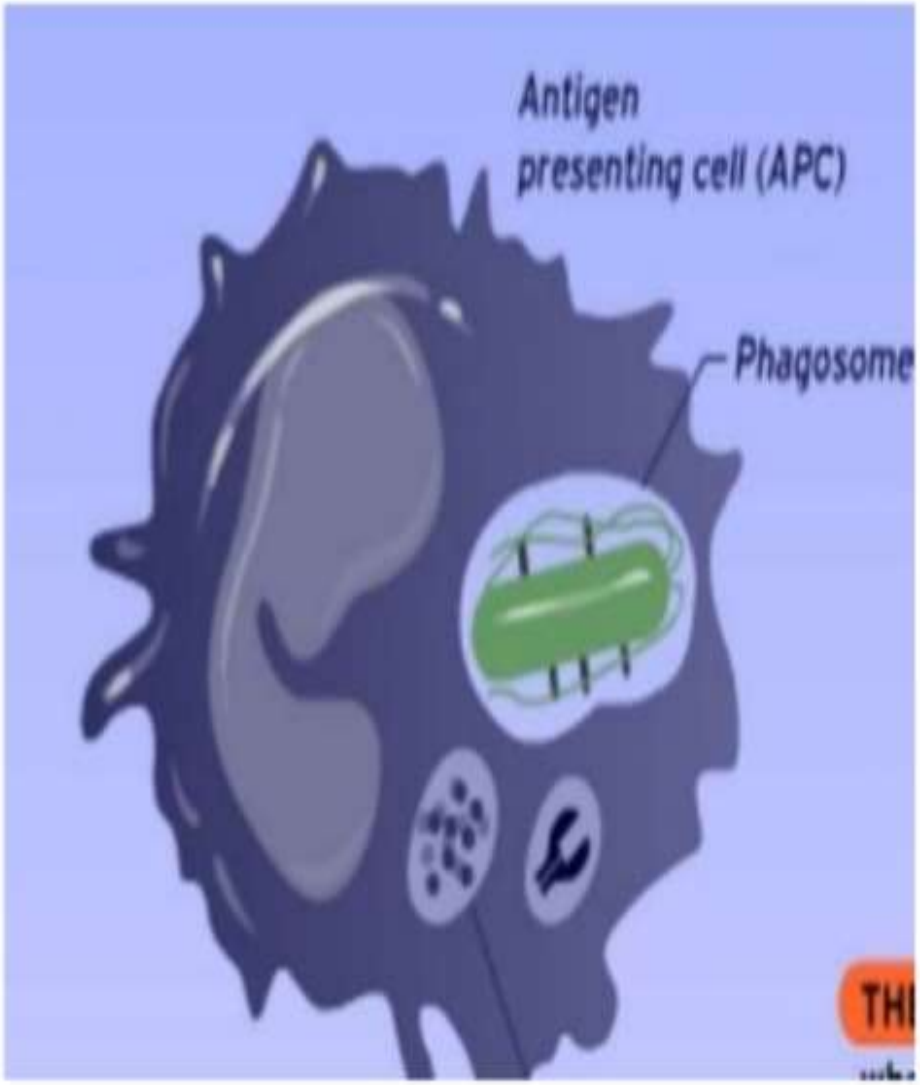
• In humoral immunity, binding of antibodies to microorganism results in the formation of immune complex (Ag-Ab complex).


Bacteria
Extracellular Spaces of the Body
Intracellular Space
Cause Infectious Disease
Protected
Humoral Immune Response

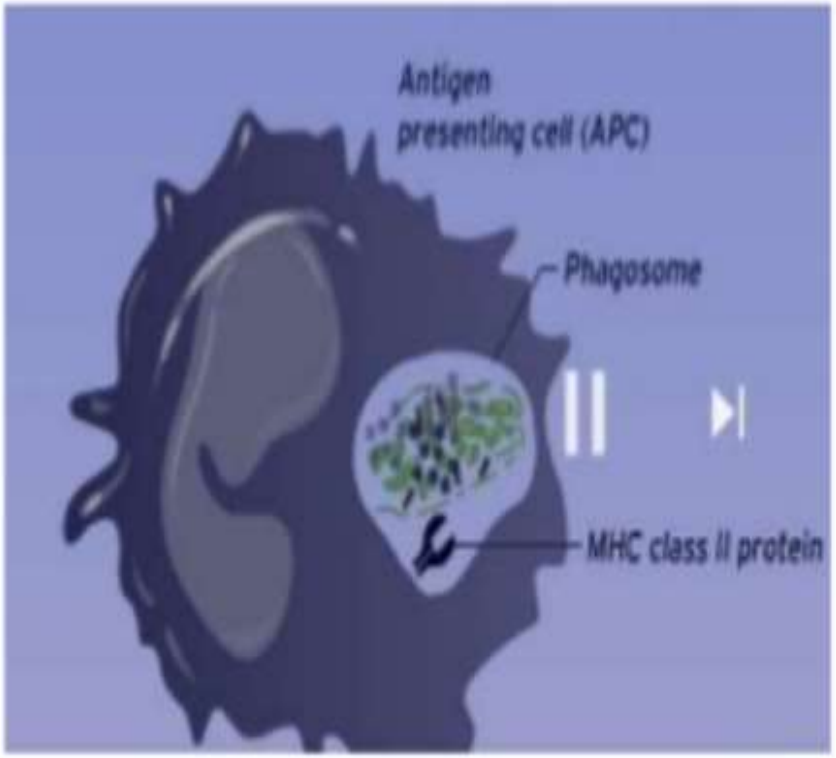
Activation phase;

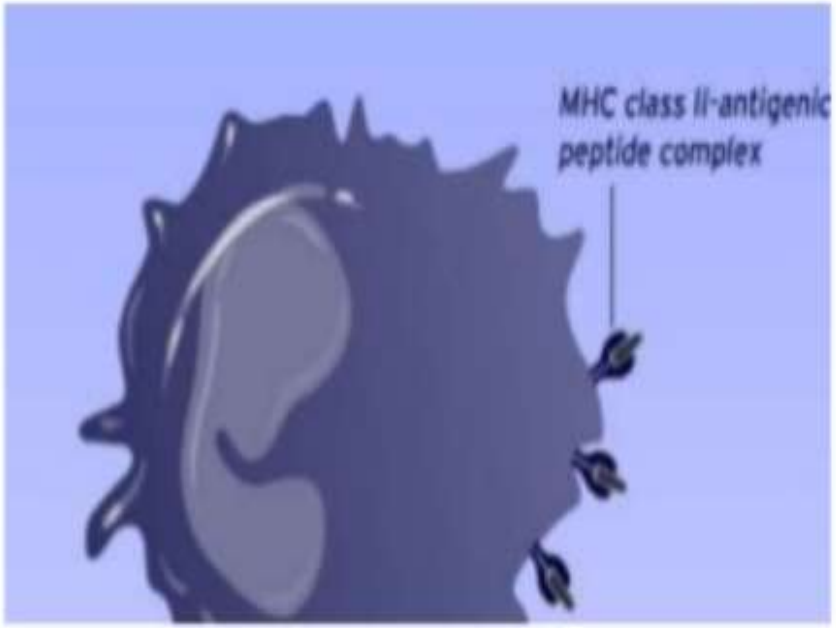
- The activation phase begins with an invading bacteria is phagocitized [engulfed] by an antigen presenting cell [APC].

- A lysosome containing digestive enzymes combines with the phagosome to process the antigen.

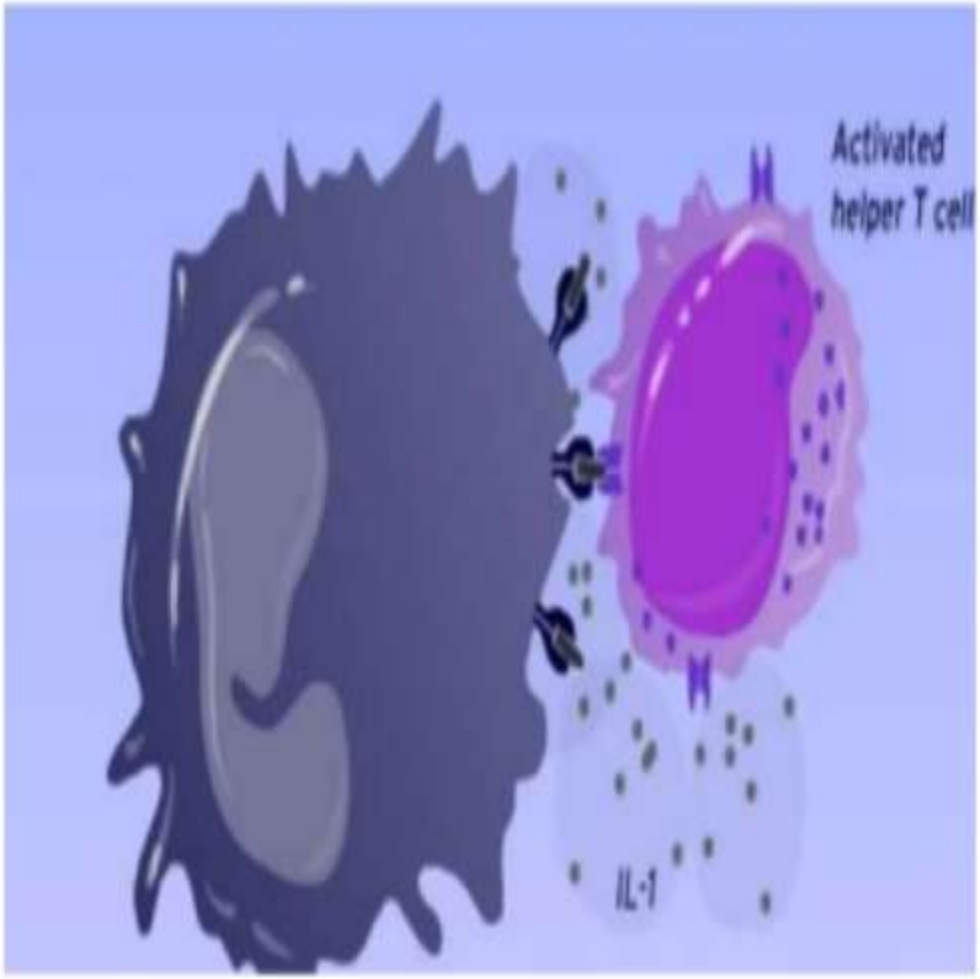


- The processed antigens combine with the MHC class II proteins and are presented on the surface of the APC.

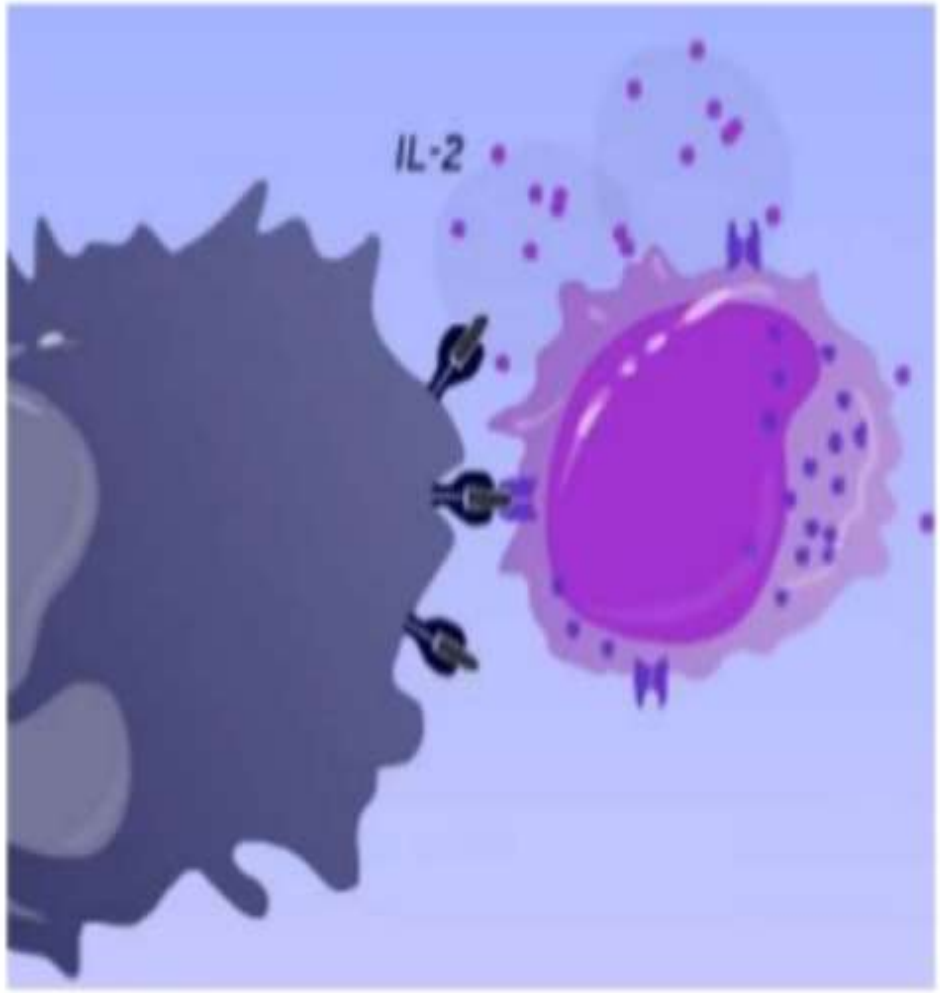




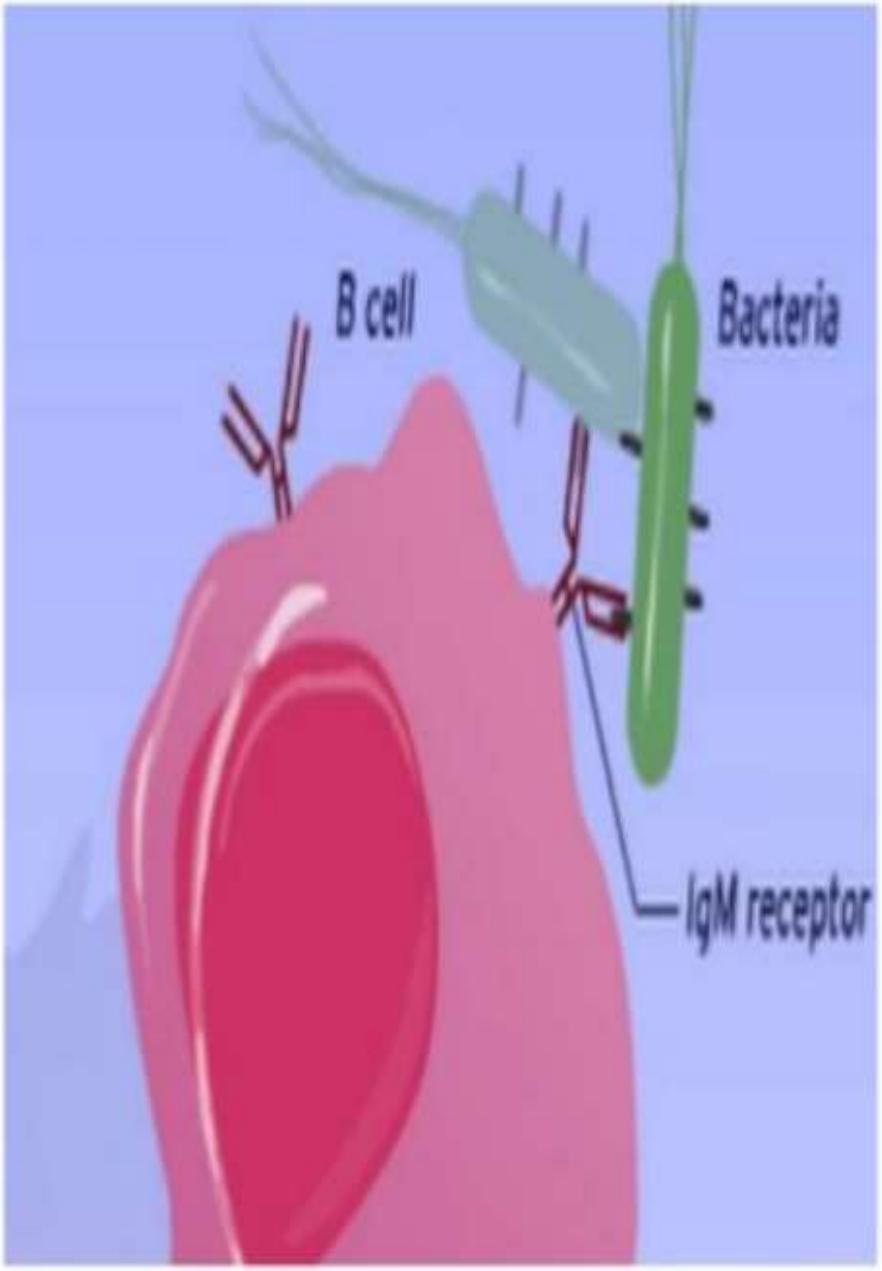
- Helper T cells [CD4+] recognize the displayed antigen on the APC and bind to the MHC class II-antigenic peptide complex.
- The binding triggers the APC to release the cytokine IL-1, which activates the Helper T cell.



- The activated Helper T cell releases the cytokine IL-2,which stimulates the helperT cell to proliferate.
- Thus, producing many HelperT cells, each with receptor specific for the original processed antigens.

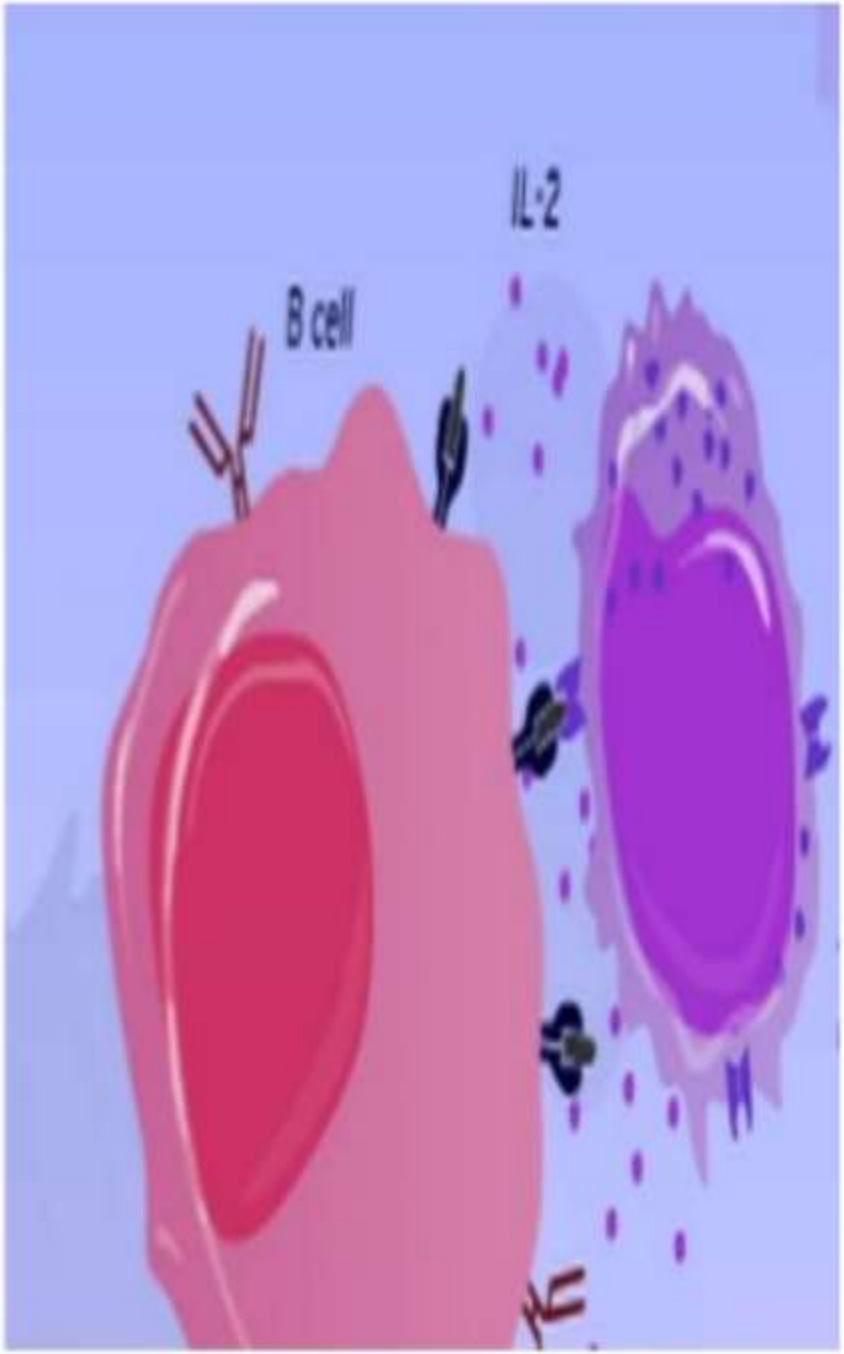


- The effector phase begins when a B cell that exhibits on its surface an IgM receptor specific for the same antigen originally engulfed by the APC encounters and binds the antigens.

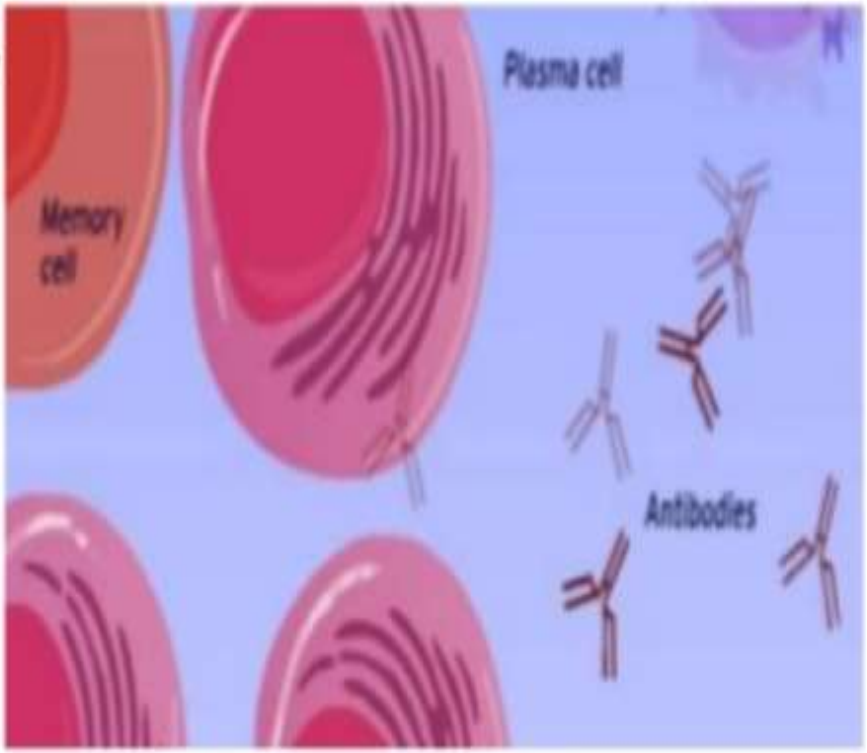


- The B cell engulfs the complex by receptor mediated endocytosis. The phagosome containing the antigens fuses with a lysosome. The antigen is processed.
- The processed antigens binds MHC class II protein and is displayed on the surface of the B Cell.

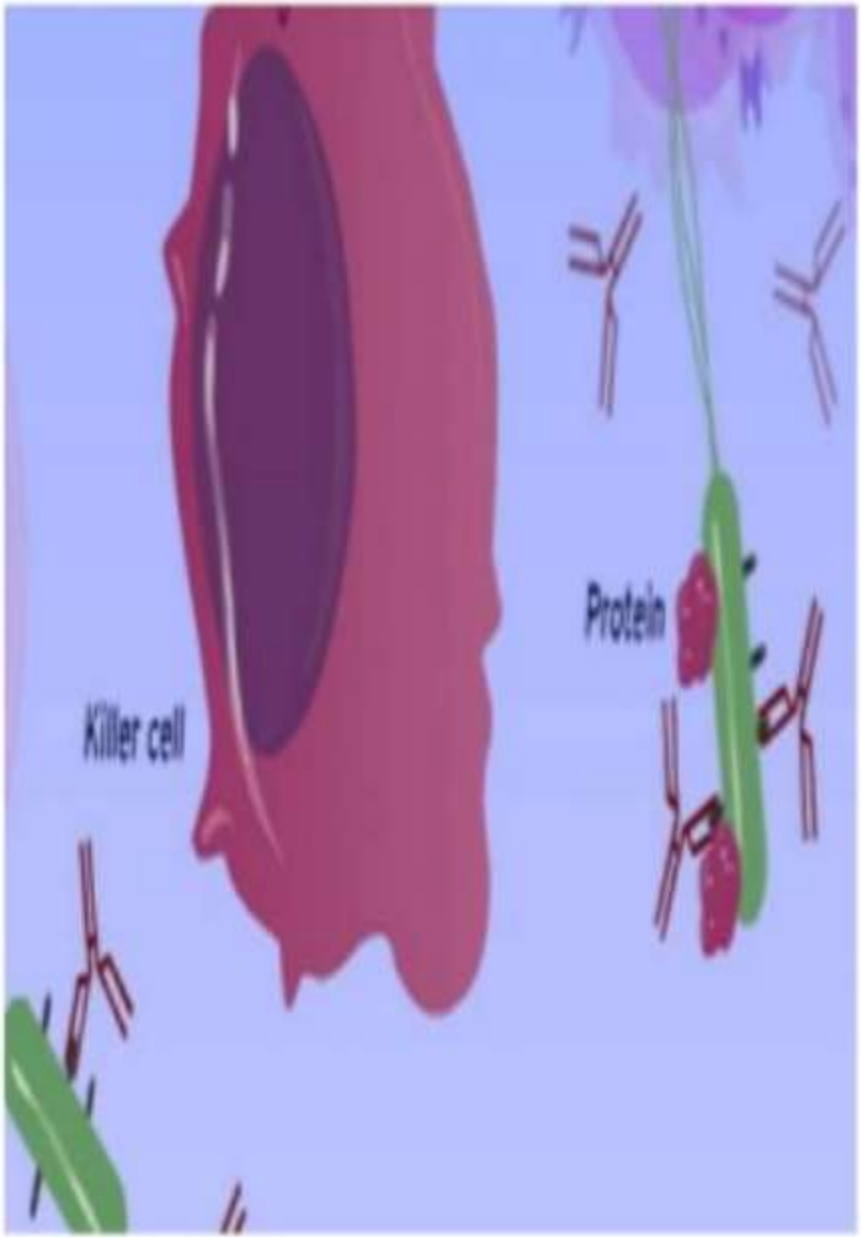
- Helper T cells now bind to the displayed antigens on the surface of the B cell causing the Helper T cell to release Cytokines.
- The cytokines stimulate the B cell to divide and proliferate into identical B cell copies.



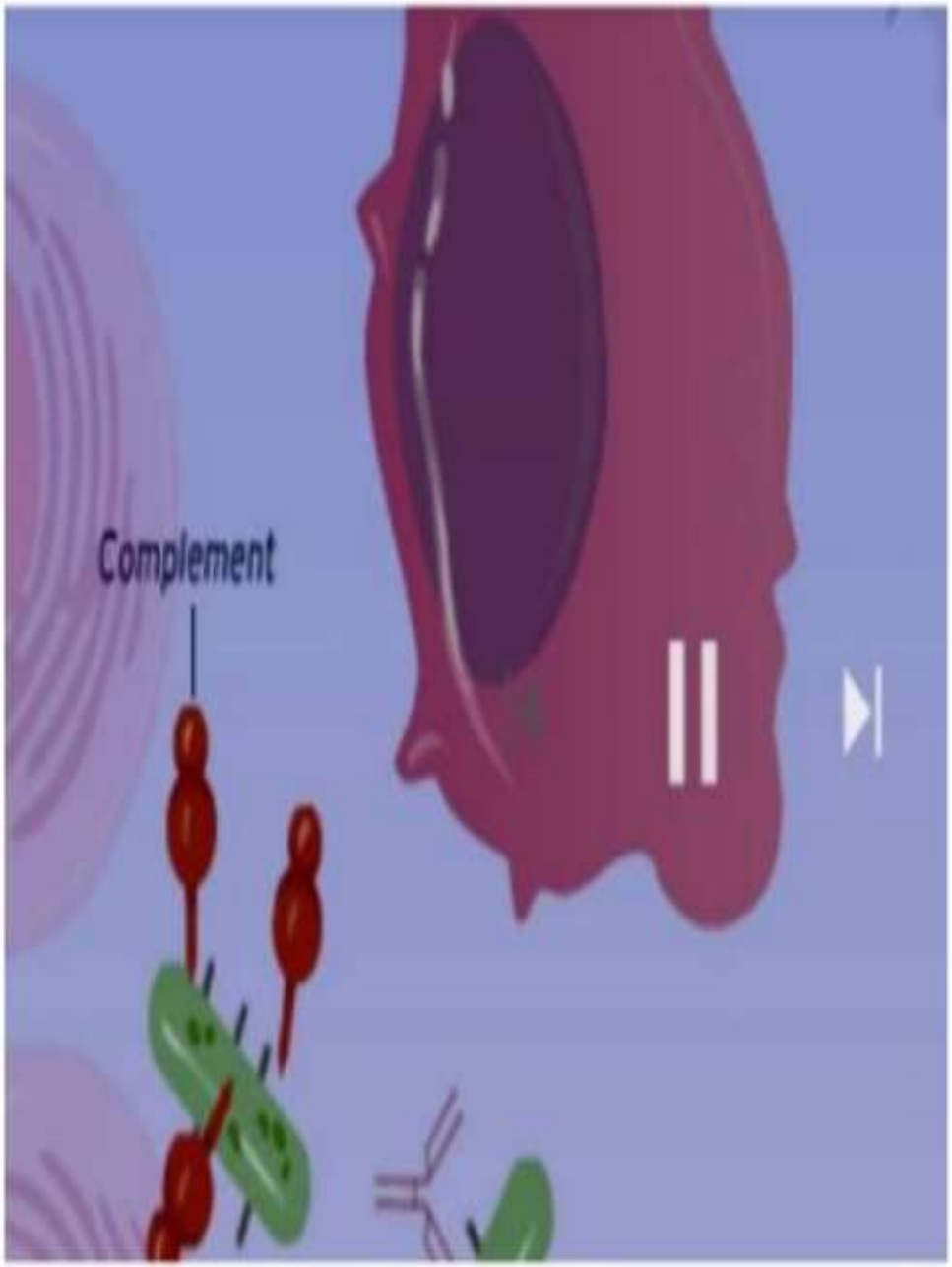
- The B cells differentiate into antibody producing plasma cells and memory cells.
- The plasma cells release antibodies with a specificity identical to that of the surface receptor on the parent B cell. These carry out the ultimate goal of fighting the foreign invaders.



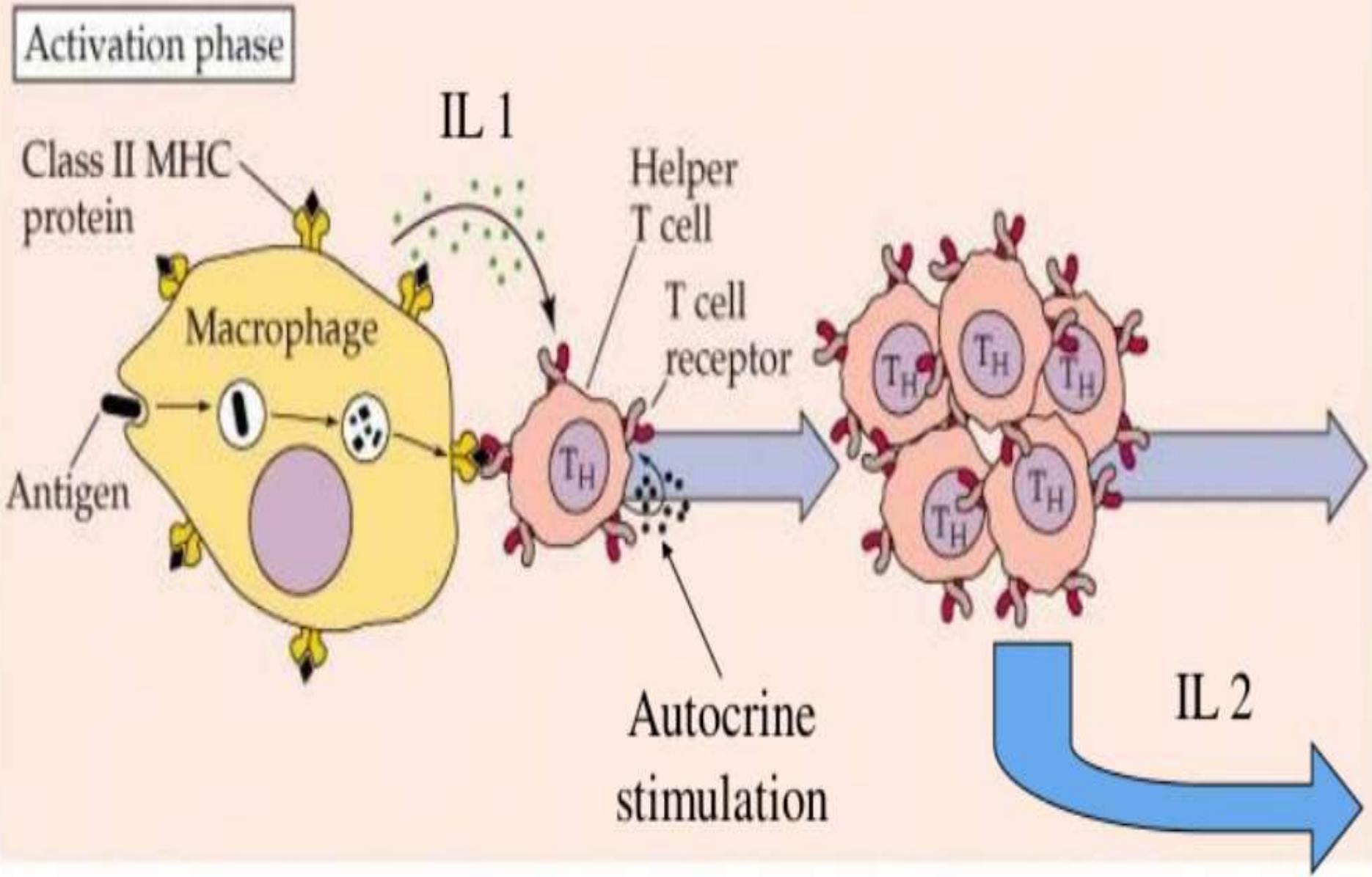
- The released antibodies bind in a lock and key fashion to the antigen on the surface of the original invaders.
- These makes it easier for killer cells to attack and destroy the bacteria by phagocytosis and release of proteins causes the direct lyses of the bacteria.

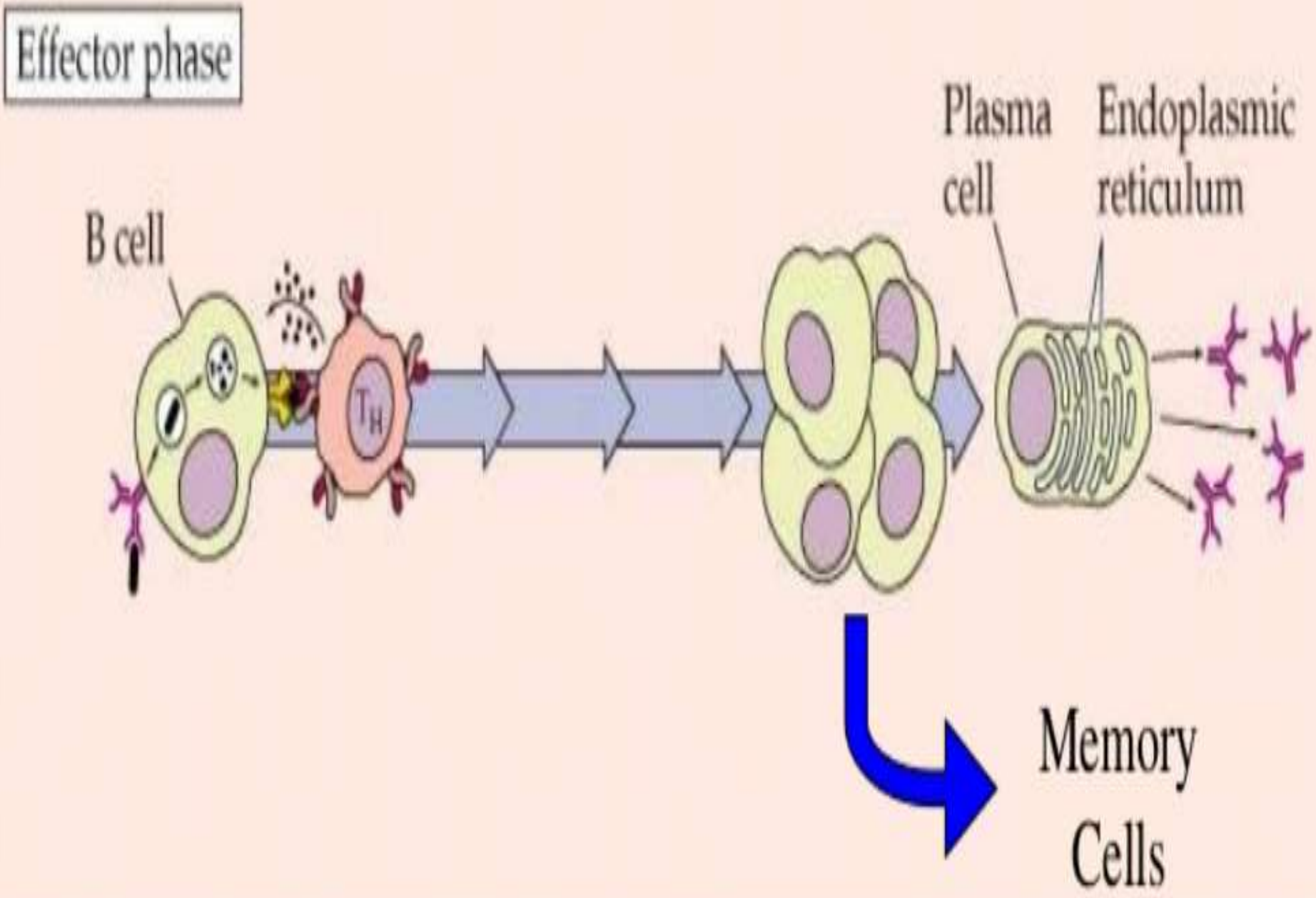


- Simultaneously a blood component known as complement is signaled to attack and puncture holes in the bacteria.



HUMORAL RESPONSE



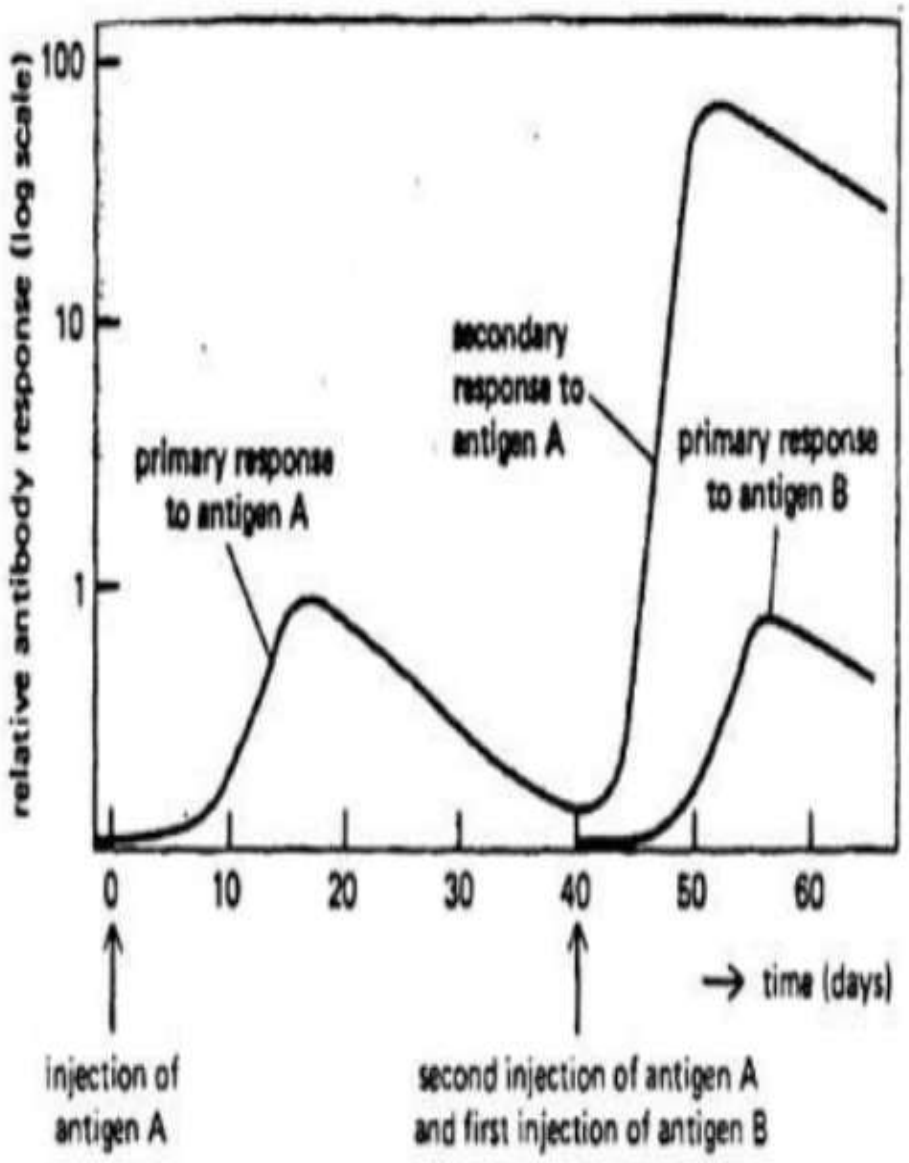

Effector phase
Plasma cell
Endoplasmic reticulum
B cell
TH
Memory Cells

➢ Functions and Properties of Antibody

- **Neutralization**
  - Direct inactivation of pathogen or toxin thereby preventing its interaction with human cells
- **Opsonization**
  - Coating of pathogens for more efficient phagocytosis
- **Activation of complement**
  - More efficient phagocytosis
  - Direct killing

Dynamics of Antibody Production

- **Primary immune response**
  - Latent period
  - Gradual rise in antibody production taking days to weeks
  - Plateau reached
  - Antibody level declines



• The preparation period that is the period between entry of pathogen and expression of immune response is known as “latent period”.

• Latent period in humoral immunity indicates activation and proliferation of naïve B cells to produce plasma cells and memory cells.

The immune response curve has four phases namely:

- Lag phase:

• Antibodies are almost absent.
• Duration of this period varies from several hours to days depending on many factors such as type and amount of antigen given, route of administration of antigen, species and health of the animal to which the antigen is injected and so on.
• For example, the lag phase is 2-3 weeks for Diphtheria toxoid and it is only a few hours with Pneumococcal antigen.

▪ Log phase: Antibodies gradually rise from zero stage to a maximum and this raising period is referred to as log phase.

▪ Stationary phase: After attaining maximum, antibody levels remain constant for some time and the period with constant antibody levels is referred as “plateau phase” .

▪ Decline phase:

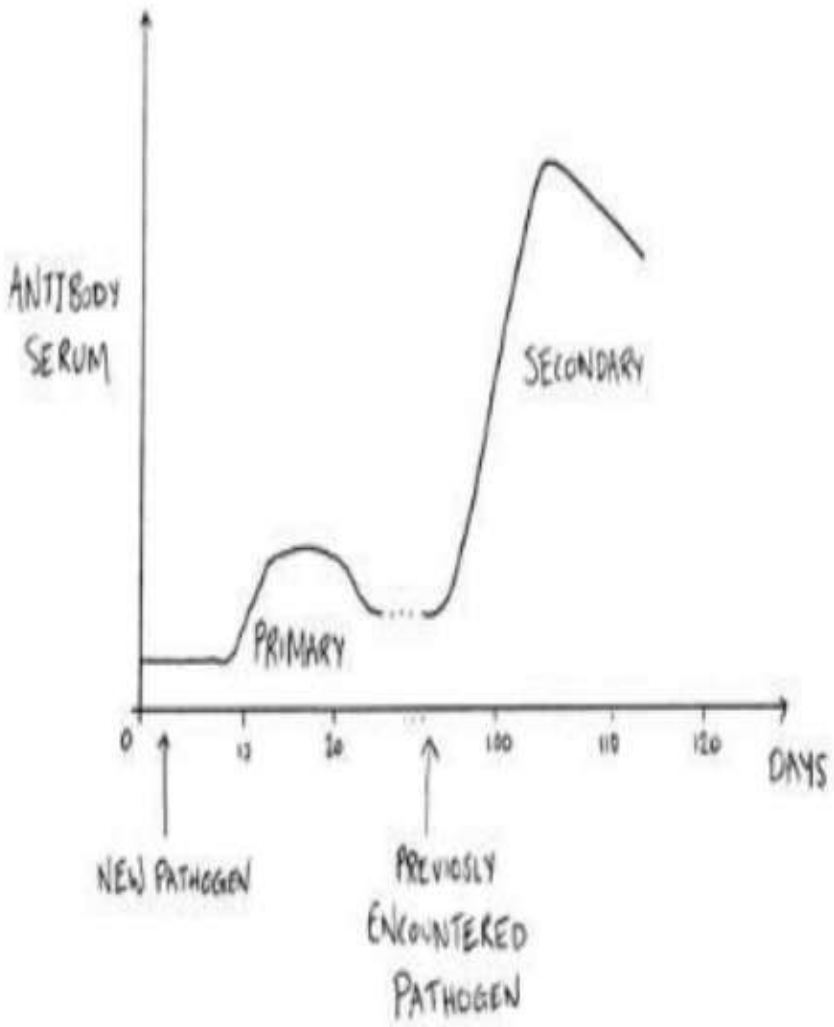
• indicates reduction of antibodies.

• Presence of antigens is necessary for the production of plasma cells and since the antigens are removed by the action of antibodies B cells failed to get stimulation from antigens and stops producing plasma cells.

• Drop in the formation of plasma cells producing antibodies leads to reduced antibodies level in the decline phase.

Secondary Response

- Second exposure to SAME antigen.
- Memory cells are a beautiful thing.
- Recognition of antigen is immediate.
- Results in immediate production of protective antibody, mainly IgG but may see some IgM



THANK YOU