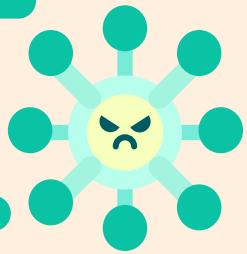
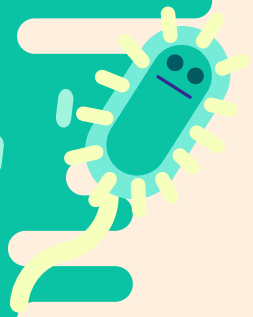




The Immune System

Anica, Zander, Caese, and Kevin

Table of Contents

Content Standards

- Be able to recognize innate response in human immune system (Non-specific).

- Be able to recognize adaptive response in human immune system (Specific).

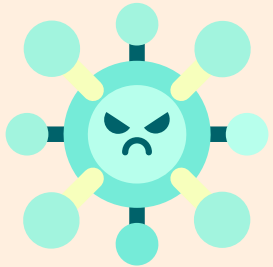
→ Humoral (B-cells)

→ Cell-Mediated (T-cells)

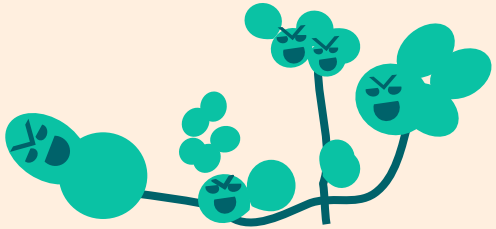
Pathogens

Pathogens are disease-causing agents.
Some examples are...

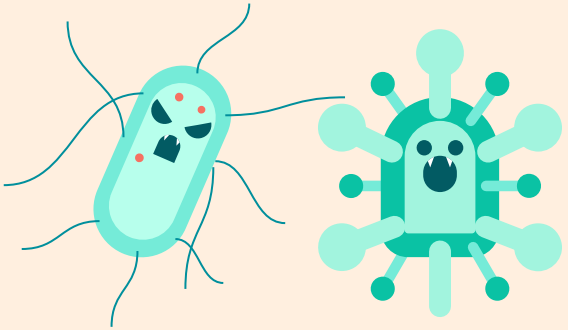
Bacteria



Uiruses



Fungi



Parasites &
Other Protists

Innate Immunity

(Non-Specific Defenses)

First Line of Defense Against Pathogens

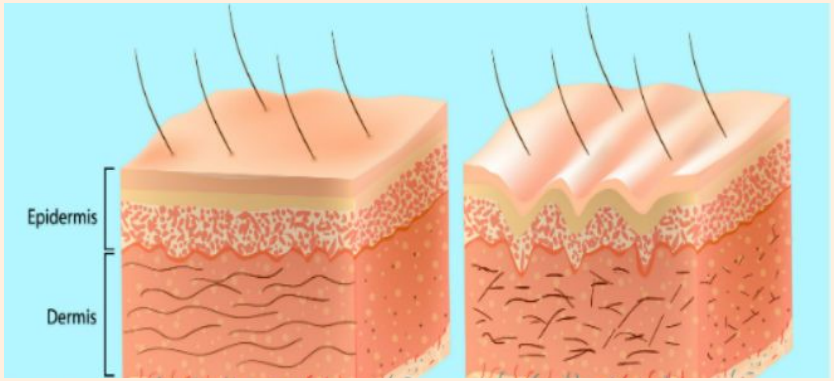
External Barriers

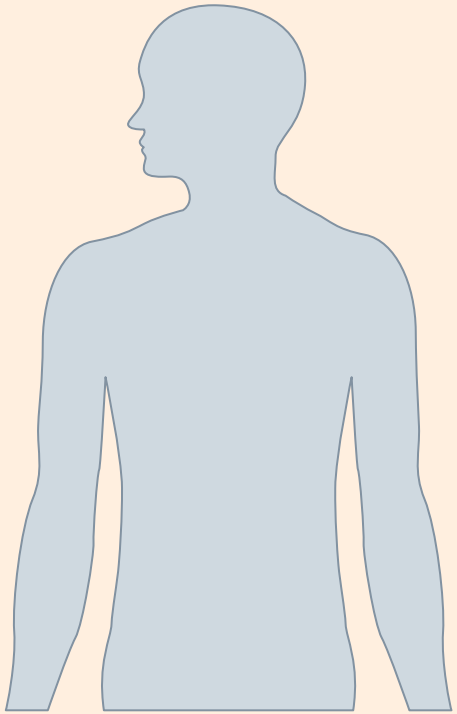
Skin

Mucous membranes

Secretions

Hair



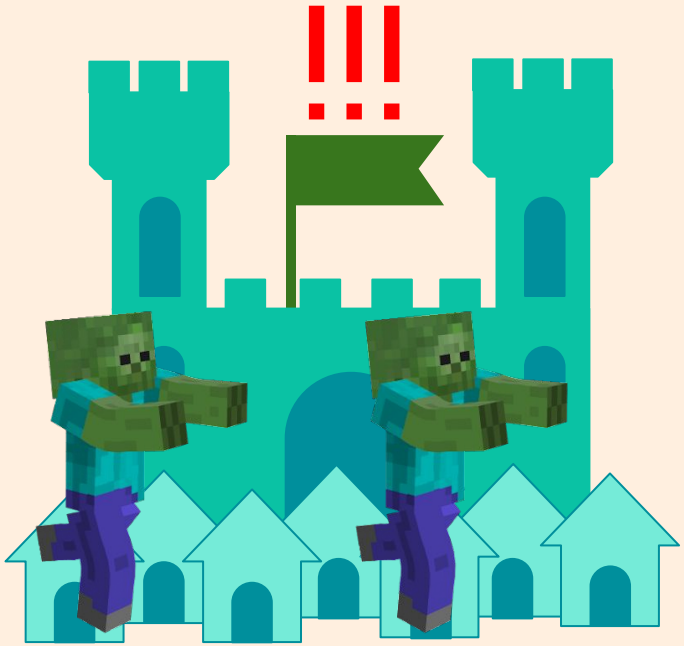


Innate Immunity

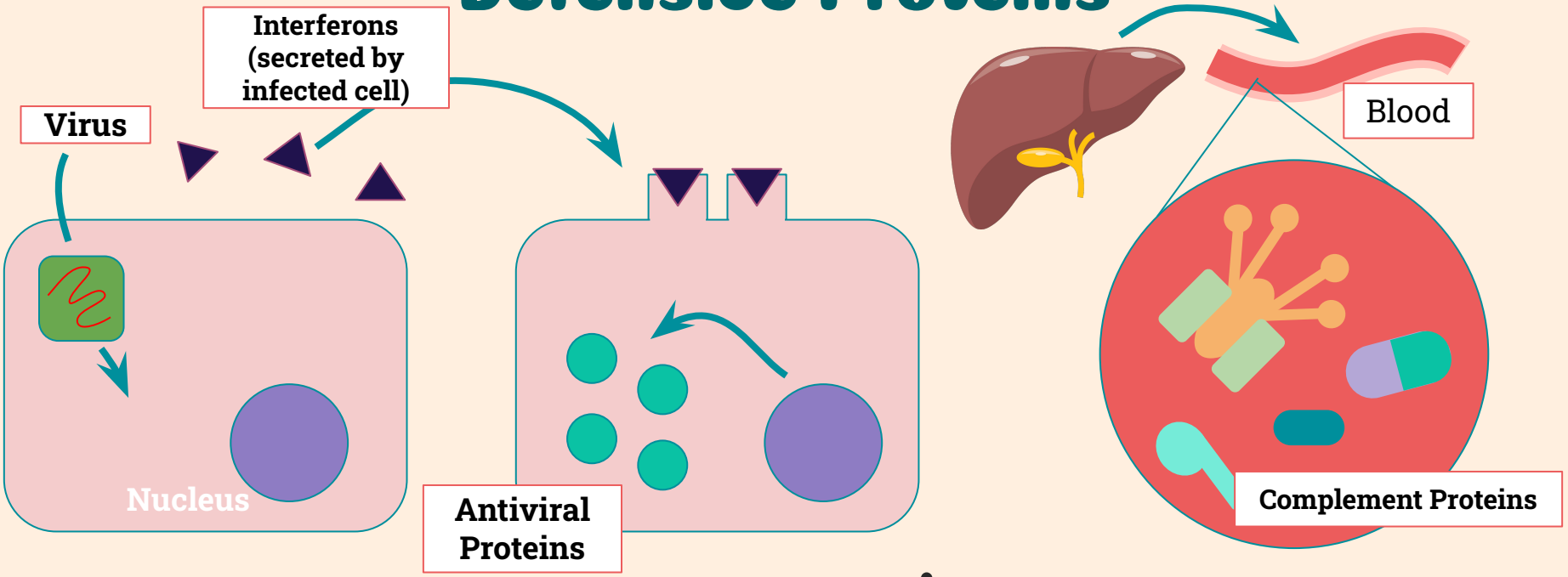
PATHOGENS

Once the EXTERNAL BARRIERS are broken…

INSIDES



Defensive Proteins



Antiviral Defenses of nearby cells

Complement cascade→series of reactions between complement proteins that bind to pathogens **inhibiting/marking** them for destruction by phagocytic cells

Neutrophils

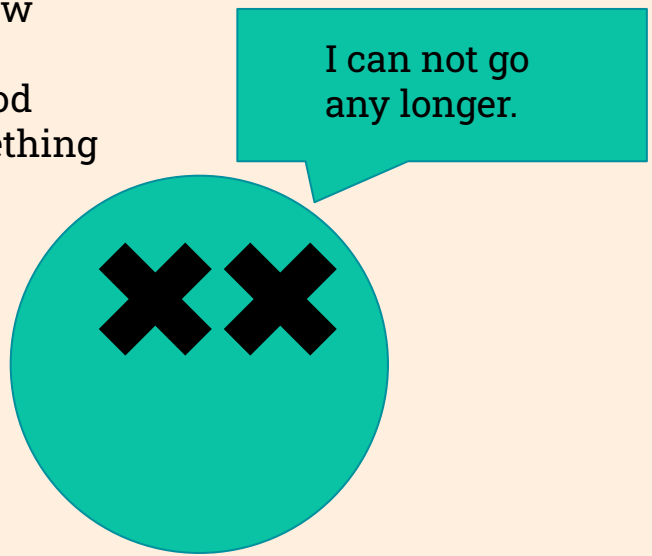
The cause of death is apoptosis

Most common leukocyte

The major early responders

Born in the bone marrow

Flow around in the blood until signalled by something in the tissue

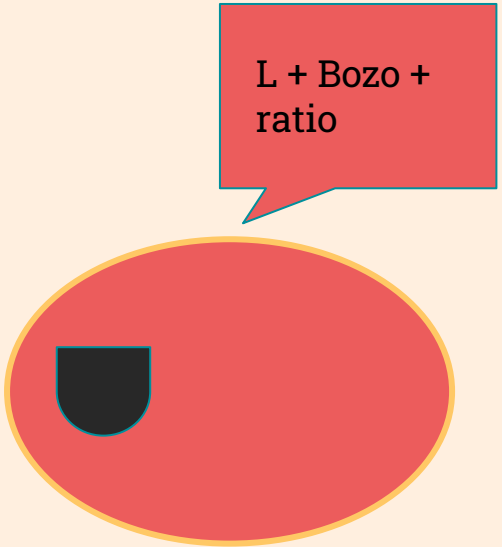


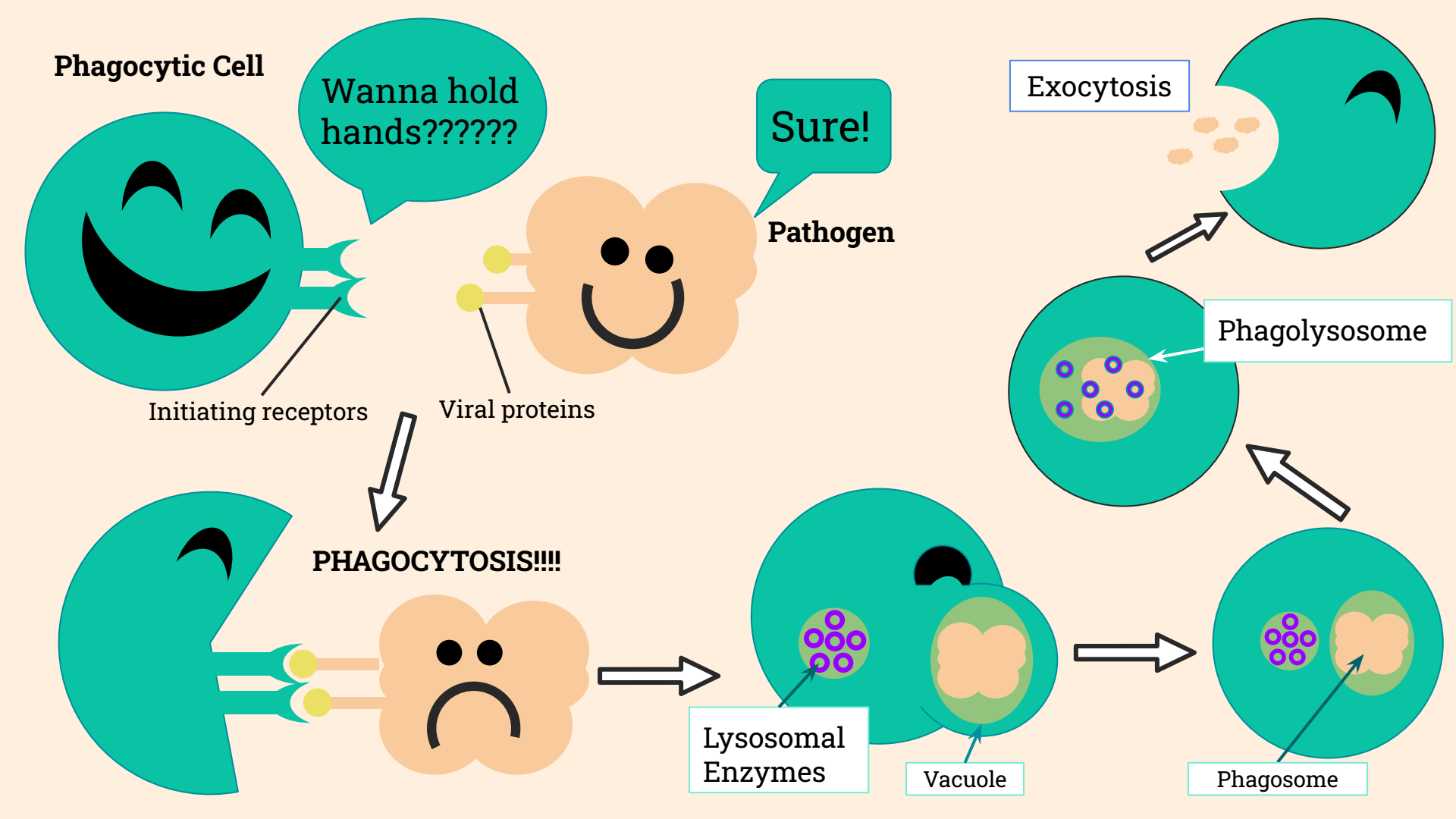
Macrophages

Can eat many pathogens

BIG

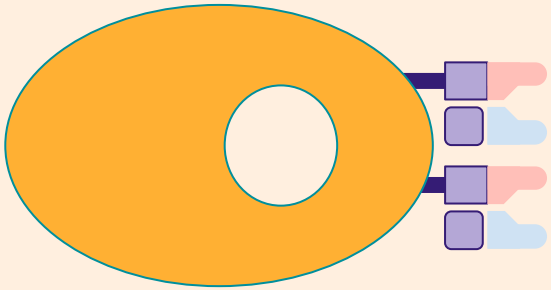
Eat and spit out invaders



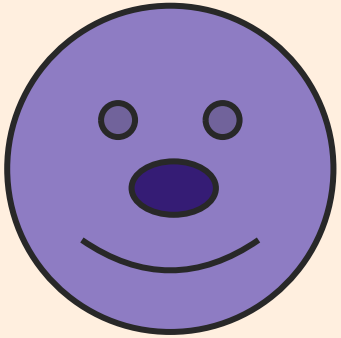

Phagocytic Cell
Wanna hold hands??????
Sure!
Pathogen
Initiating receptors
Viral proteins
PHAGOCYTOSIS!!!!
Lysosomal Enzymes
Vacuole
Phagosome
Phagolysosome
Exocytosis

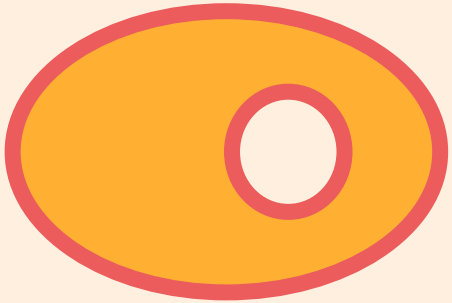
NATURAL KILLER (NK) CELLS

Cells express Class 1 MHC molecules that inhibit NK response by saying they're doing fine and not doing anything sus

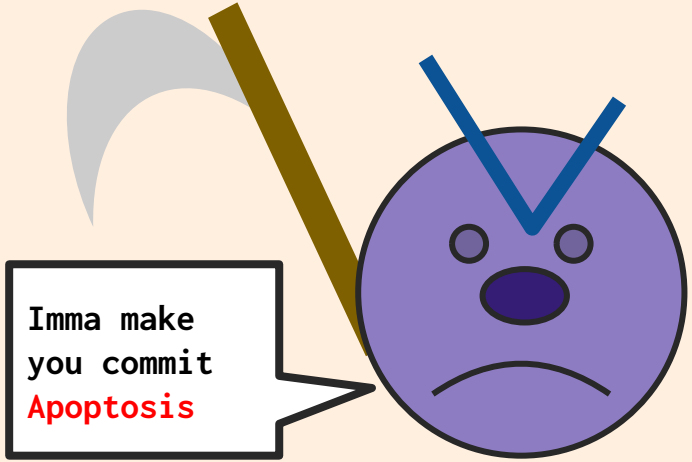


Normal amount being expressed == HAPPY! NO KILL (NK response is **inhibited**)

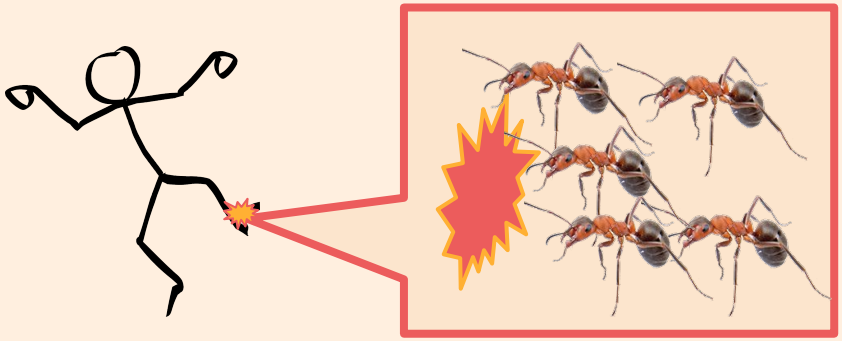


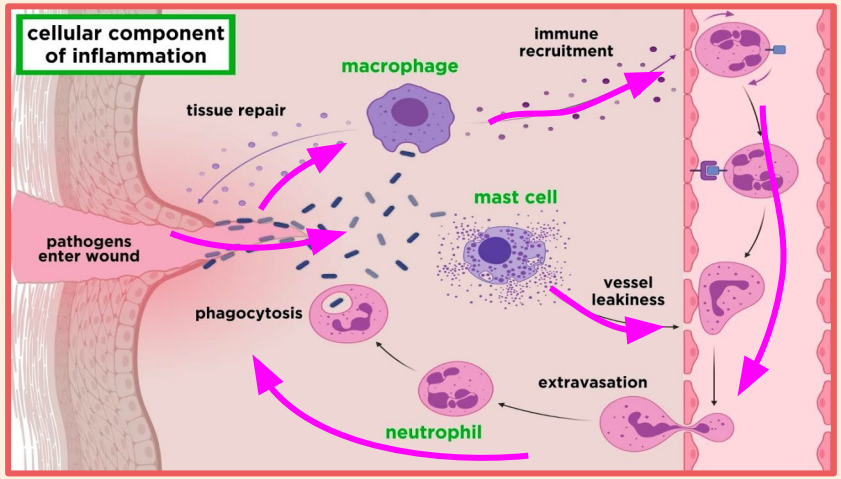


Abnormal (too much/little) being expressed == ANGERY KILL (NK cells induce **apoptosis**)



INFLAMMATORY RESPONSE





- Suppose a fire ant (or an entire SWARM >.>) bites you. Within a minute, your skin swells and a bump at the site of the bite raises. Your vessels swell, and by the end of the day, a blister filled with pus appears.

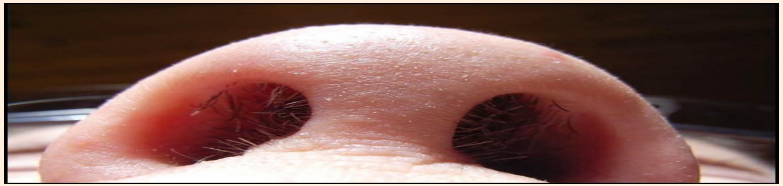
- Your tissue is broken and venom is injected, which is considered by your body to be a **pathogen**. When the invading ***antigen*** binds to receptors on the **mast cells**, the mast cells activate and release **inflammatory chemicals** like **histamine** that promote **vasodilation** (vessels get bigger, slows pathogen spread).

- **Macrophages** attack the pathogen as well and secrete **cytokines**, which then recruit and proliferate more immune cells, promoting the response.

- **Neutrophils** enter the tissue through extravasation and eliminate the pathogen. Their dead bodies become the **pus** that fills your blister.

Innate Immunity Review

External Barriers



↓

Defensive Proteins

→ Interferons
→ Complement Proteins

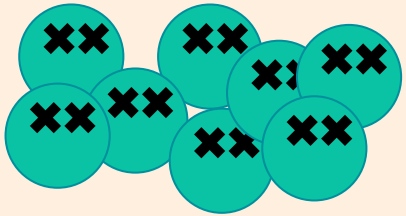
↓

Cells

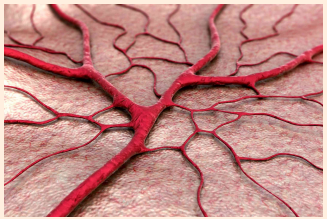
→ Phagocytic Cells
  → Neutrophils
  → Macrophages
→ Natural Killer Cells

↓

Inflammatory Response



Pus == dead neutrophils



Capillaries get swole

Adaptive Immunity

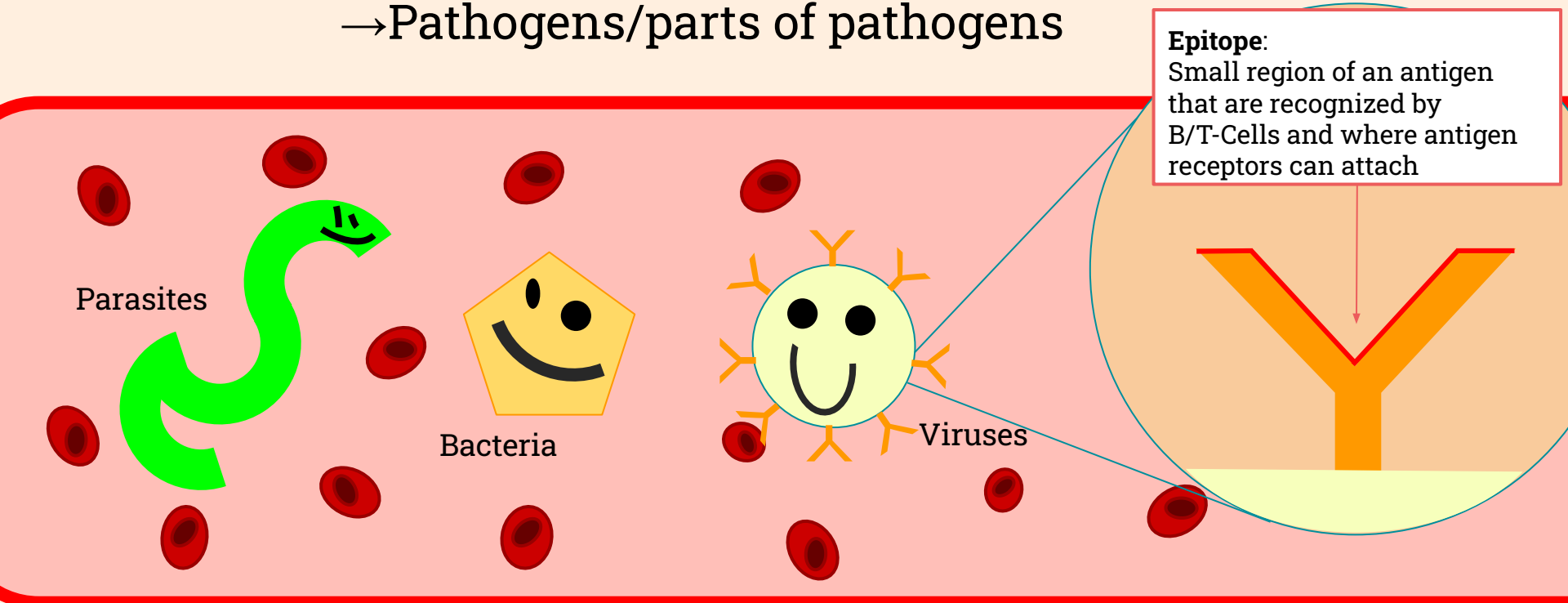
(Specific Defenses)

Adaptive Immunity

- Involves specialized white blood cells called “lymphocytes”
- Responsible for memorizing specific pathogens
- Activated when...
  - →Innate defenses need reinforcements
  - →A new pathogen is encountered
- It is slower than innate immunity because of the time it takes to identify and respond to new pathogens.

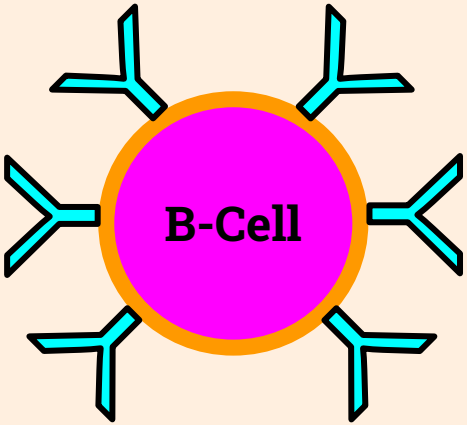
Antigens

Any foreign substance that triggers an adaptive immunity response.
→Pathogens/parts of pathogens



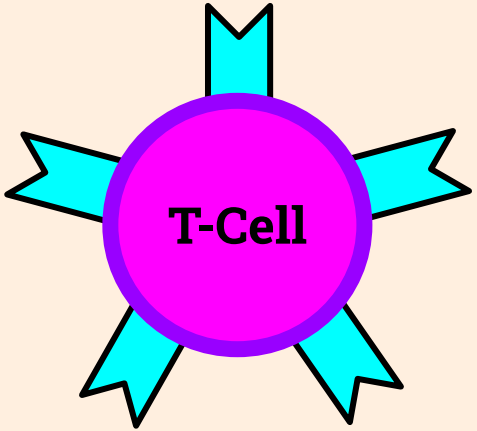
Players of Adaptive Immunity
Lymphocytes
(Special Leukocytes)

Humoral Response



- Mature in bone marrow
- Responsible for Humoral Response

Cell-Mediated Response

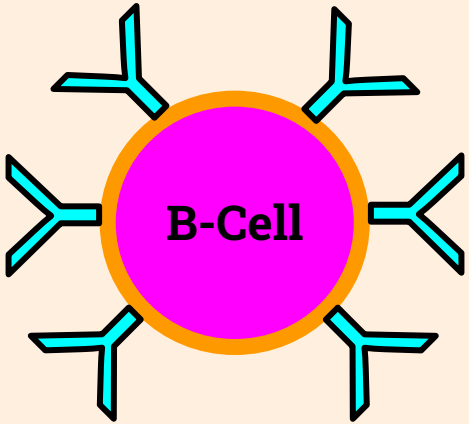


- Originate in bone marrow → mature in Thymus
- Responsible for Cell Mediated Response

Lymphocytes

(Special Leukocytes)

Humoral Response

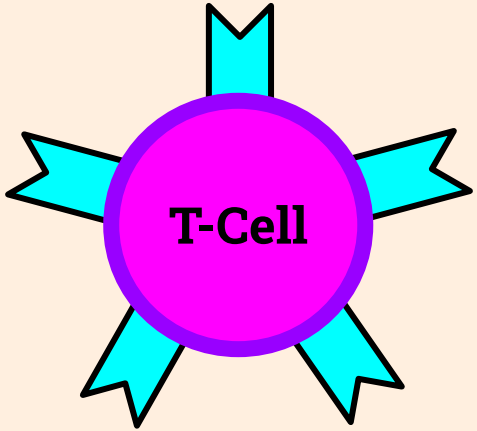


- Responds to pathogens with the secretion of antibodies in blood and other body fluids.
- Attacking free floating pathogens who have not yet infected body-cells (extracellular pathogens).

Lymphocytes

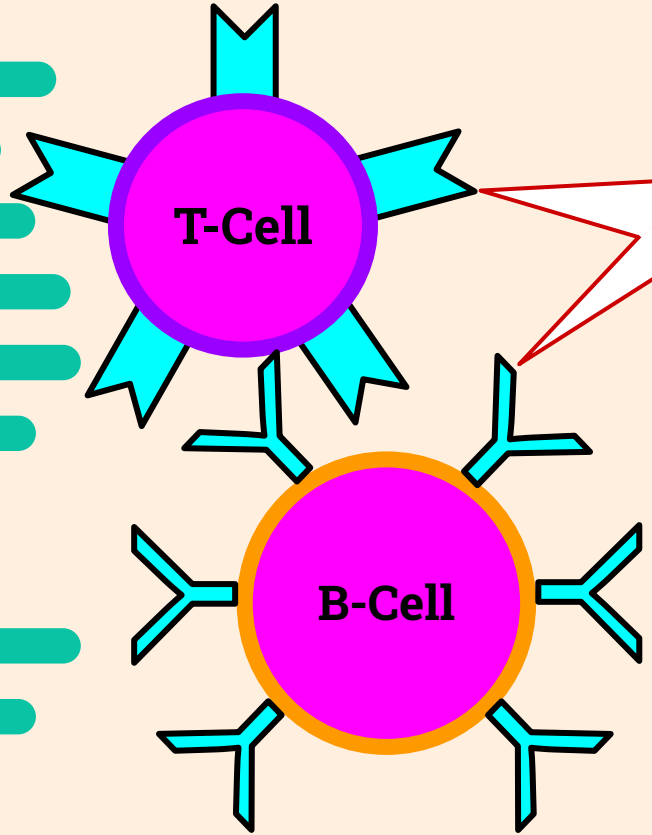
(Special Leukocytes)

Cell-Mediated Response



- **Responds to pathogens by causing them to lyse through enzymes and proteins.**
- **Attacks cells infected with antigens (intracellular pathogens).**

Structure of Lymphocytes



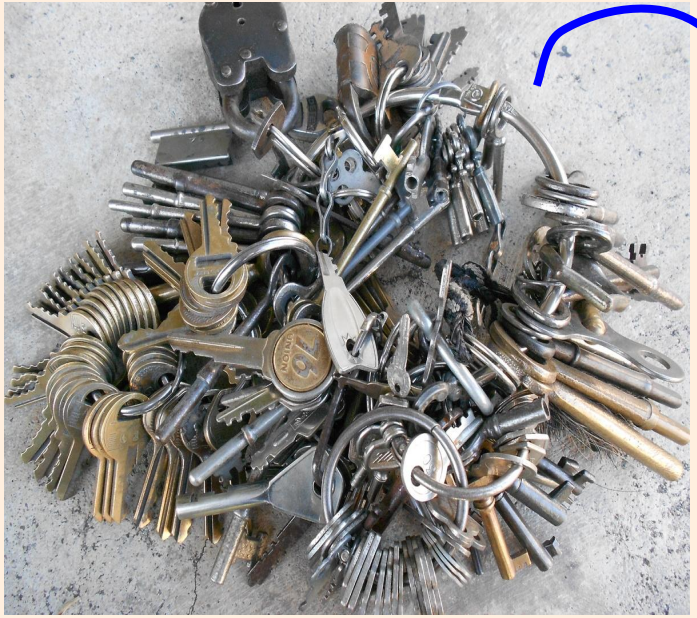
B & T Cells have Proteins called "antigen receptors."

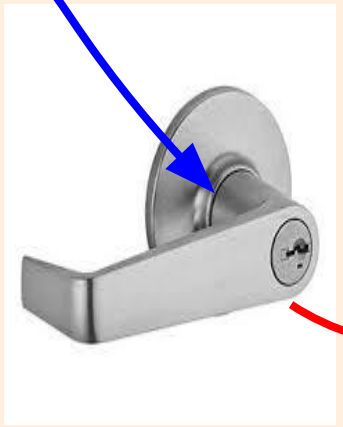
→Antigen receptors are responsible for recognizing antigens.

→These receptors are "specific" to a certain pathogen epitope.

→The body has thousands of these proteins in different variations.

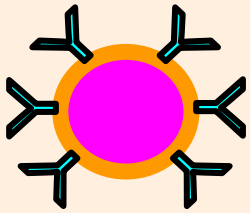
Key-House Analogy

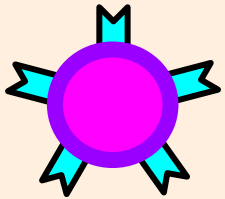




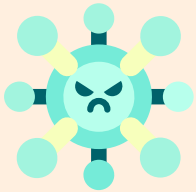
Epitope

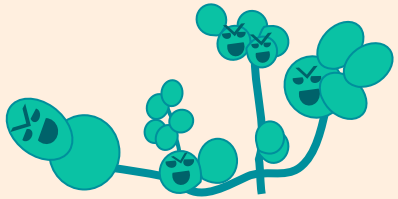
B & T Cells many Antigen Receptors





Pathogens



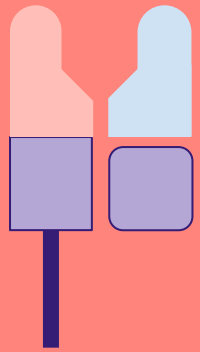


Humoral Response

Major Histocompatibility Complex Proteins

Class I MHC

Found in most nucleated cells



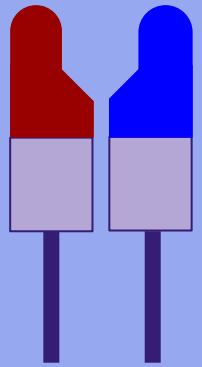
Differing structures

Presents antigens inside the cell (internal)

Presents to Cytotoxic T-Cells & NK cells

Class II MHC

Found only in antigen presenting cells



Differing structures

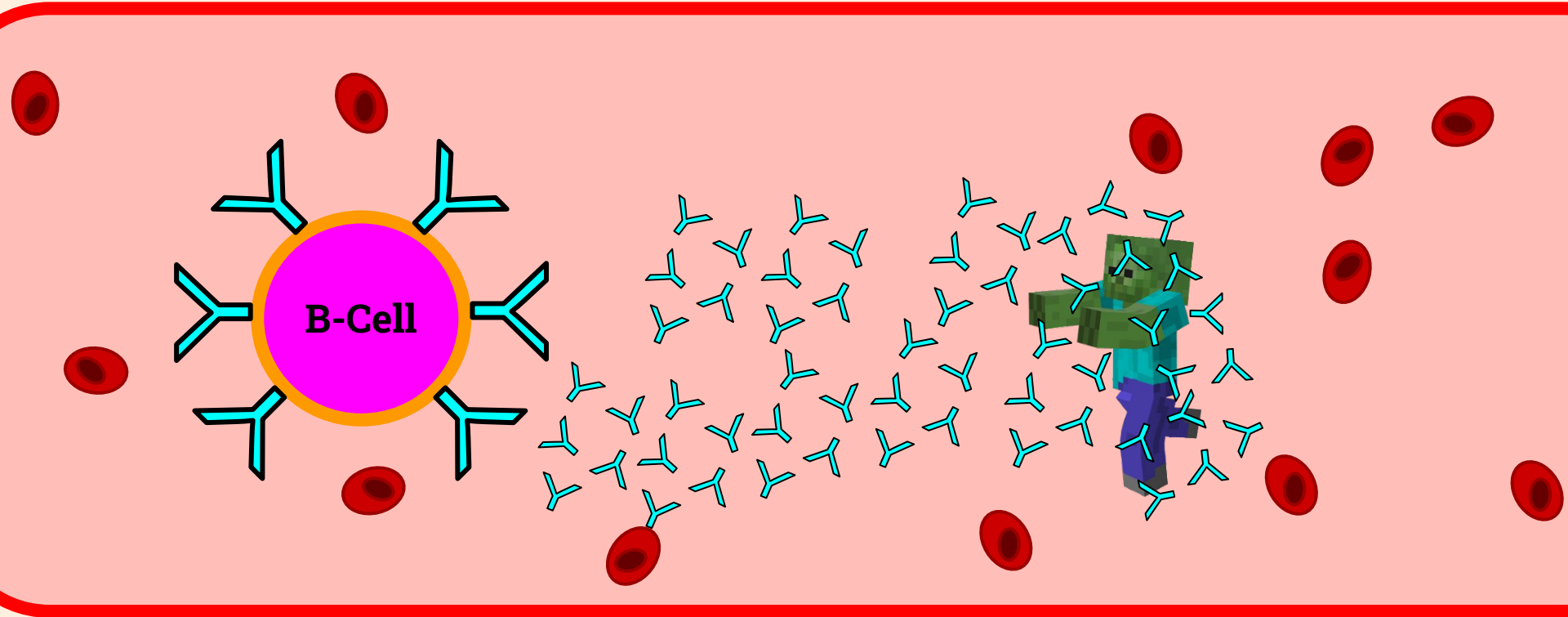
Presents antigens free floating in the body (external)

Presents to Helper T-Cells

Present antigens on a cell's membranes to immune cells, causing an immune response

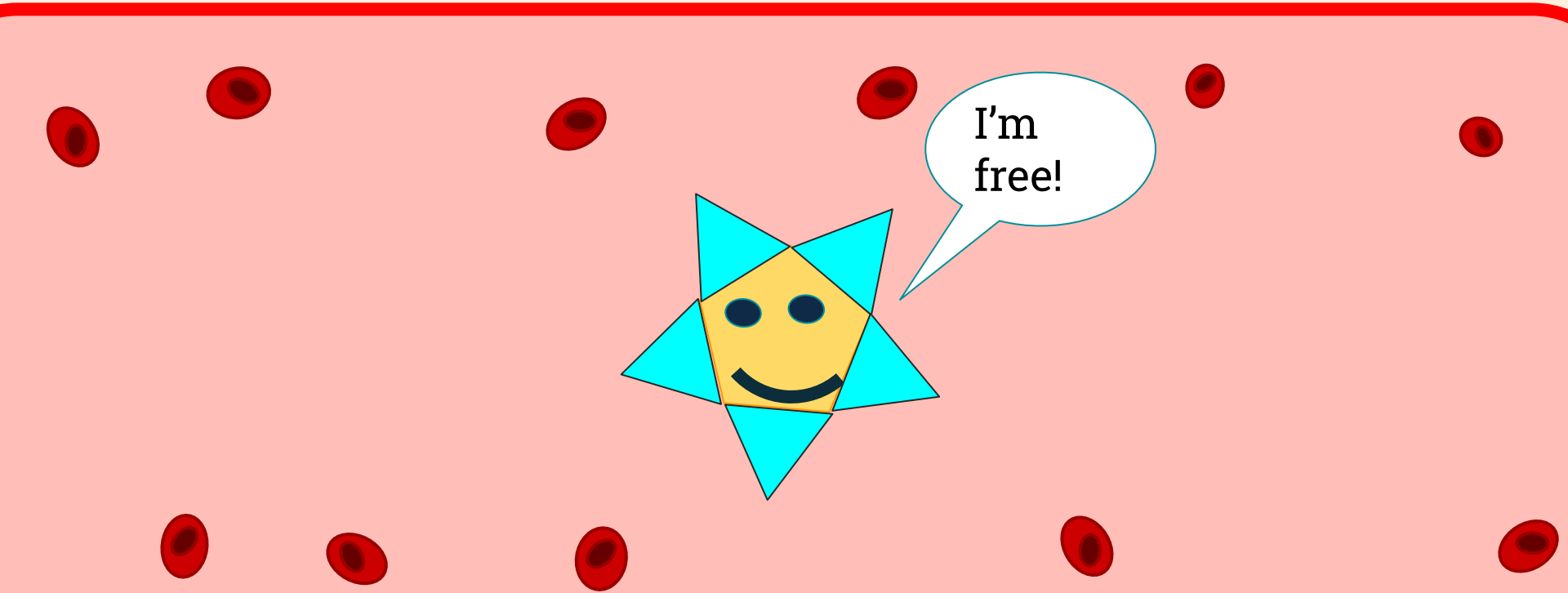
Humoral Response

- When B-cells attack pathogens with Antibodies



Humoral Response Activation

When the body is exposed to the pathogen, making it past innate defenses,

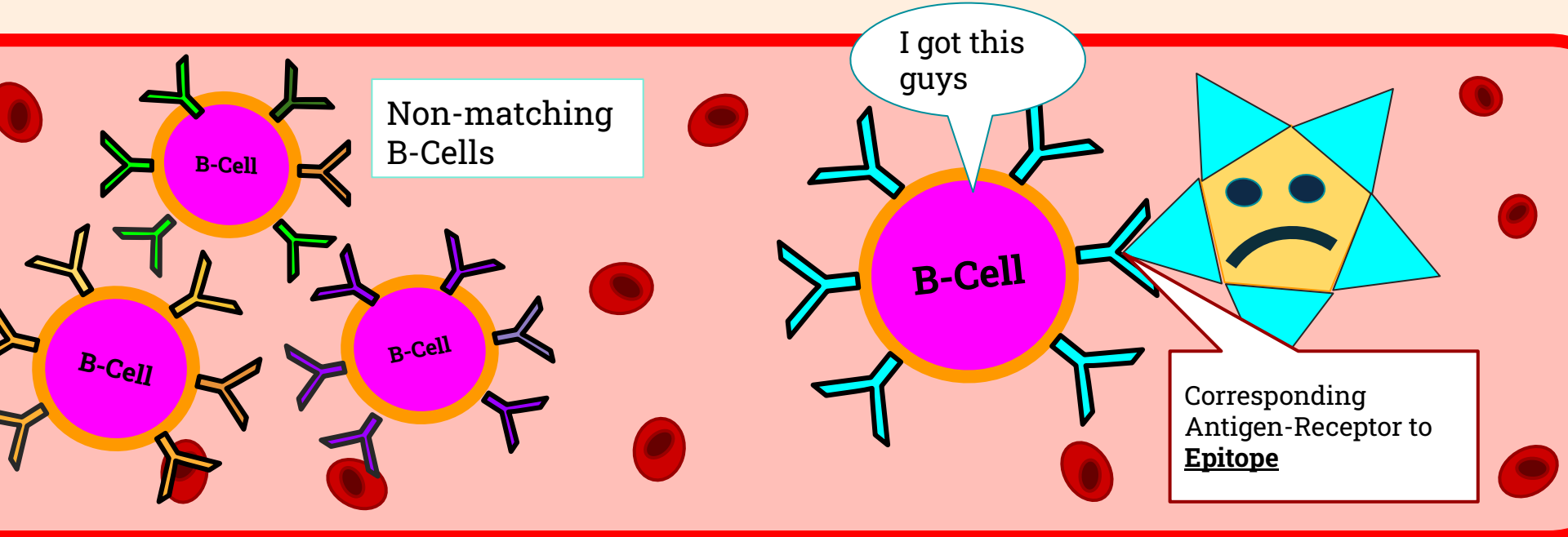


Humoral Response Activation

B-Cell randomly finds pathogen

↓

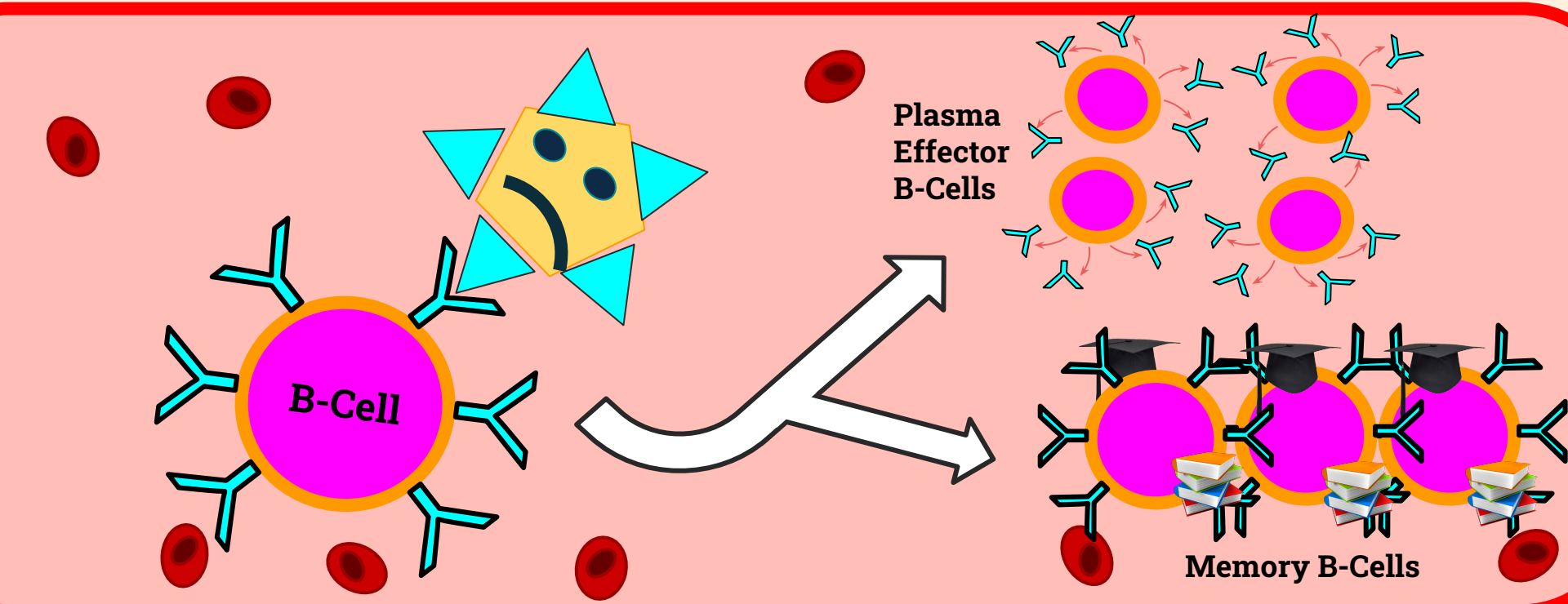
B-Cell binds to antigen via **antigen receptor that corresponds to epitope**



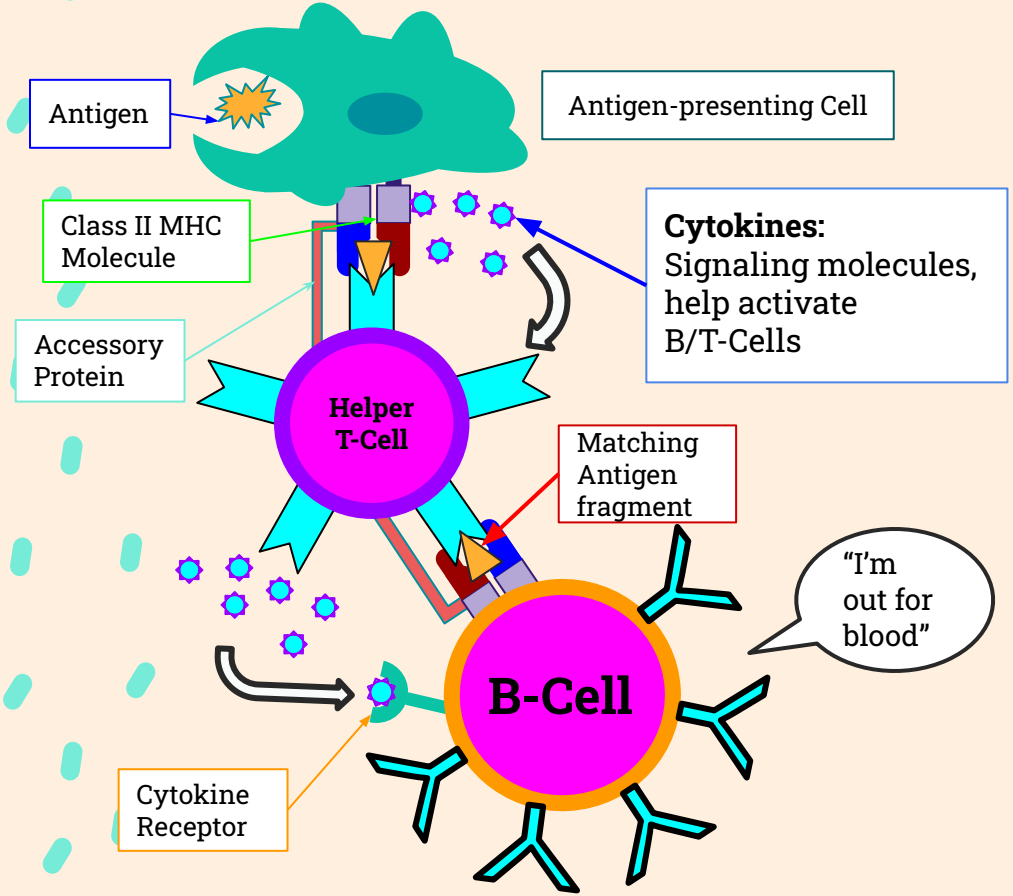
Humoral Response and Clonal Selection

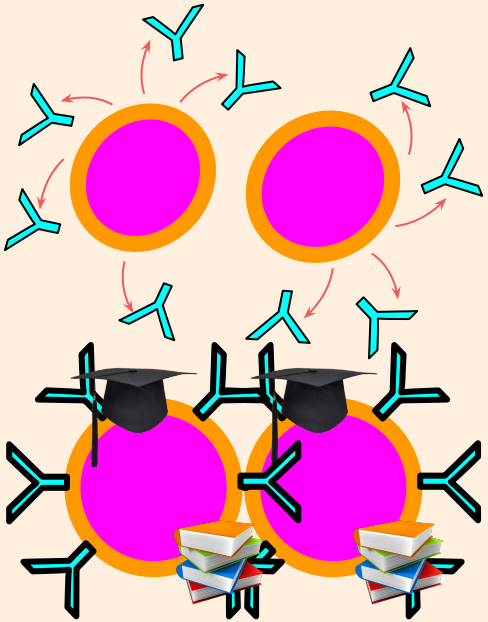
Once matched, the B-Cell

undergoes clonal selection



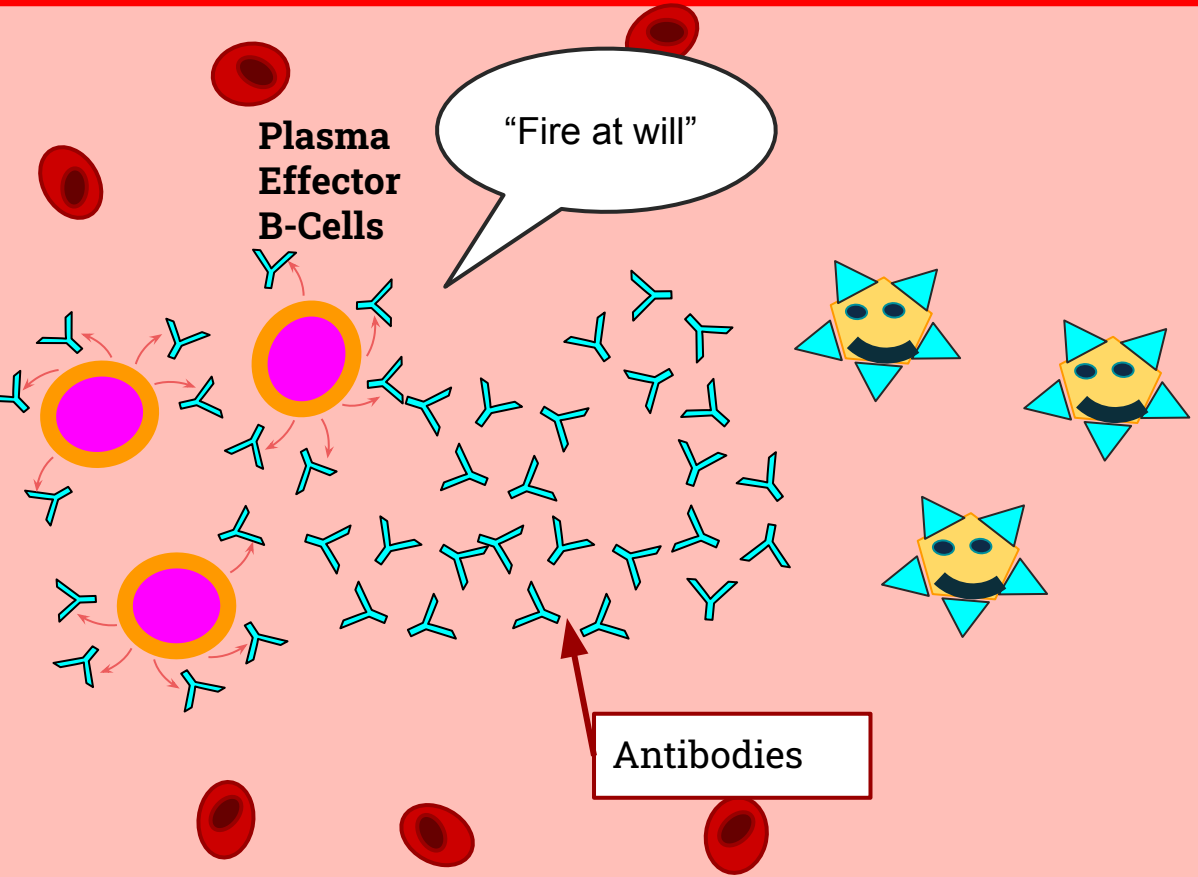
Alternative Humoral Response Activation





CLONAL SELECTION

Plasma Effector Cells



→Are responsible for **secreting antibodies.**

→Because the **B-Cell antigen receptor is <u>specific</u> to that pathogen,** the B-Cell clones **<u>plasma effector cells</u>** that secrete **antibodies <u>specific</u> to that antigen** and its **<u>epitope</u>.**

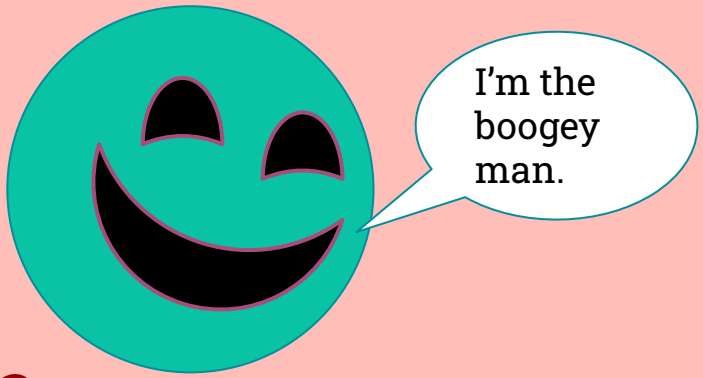
What Antibodies do

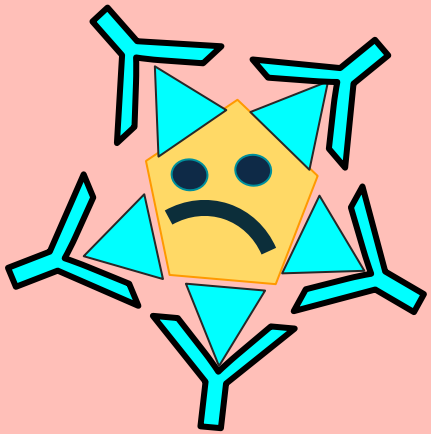
Antibodies <u>disable and prevent pathogens from spreading</u> in TWO WAYS:

1. <u>Opsonization</u>

When antibodies mark pathogens for phagocytes to consume.

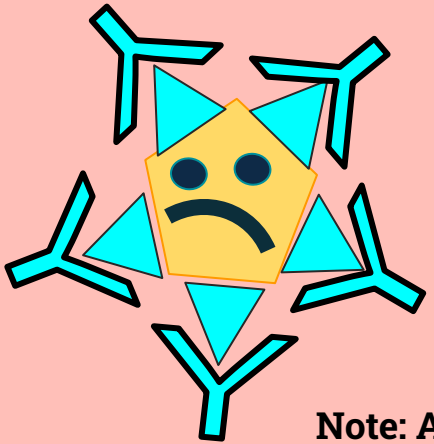
Macrophage

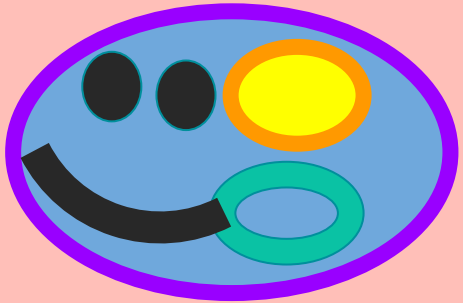




What Antibodies do

2. <u>Neutralization</u>
When antibodies prevent pathogens from sticking to body cells.

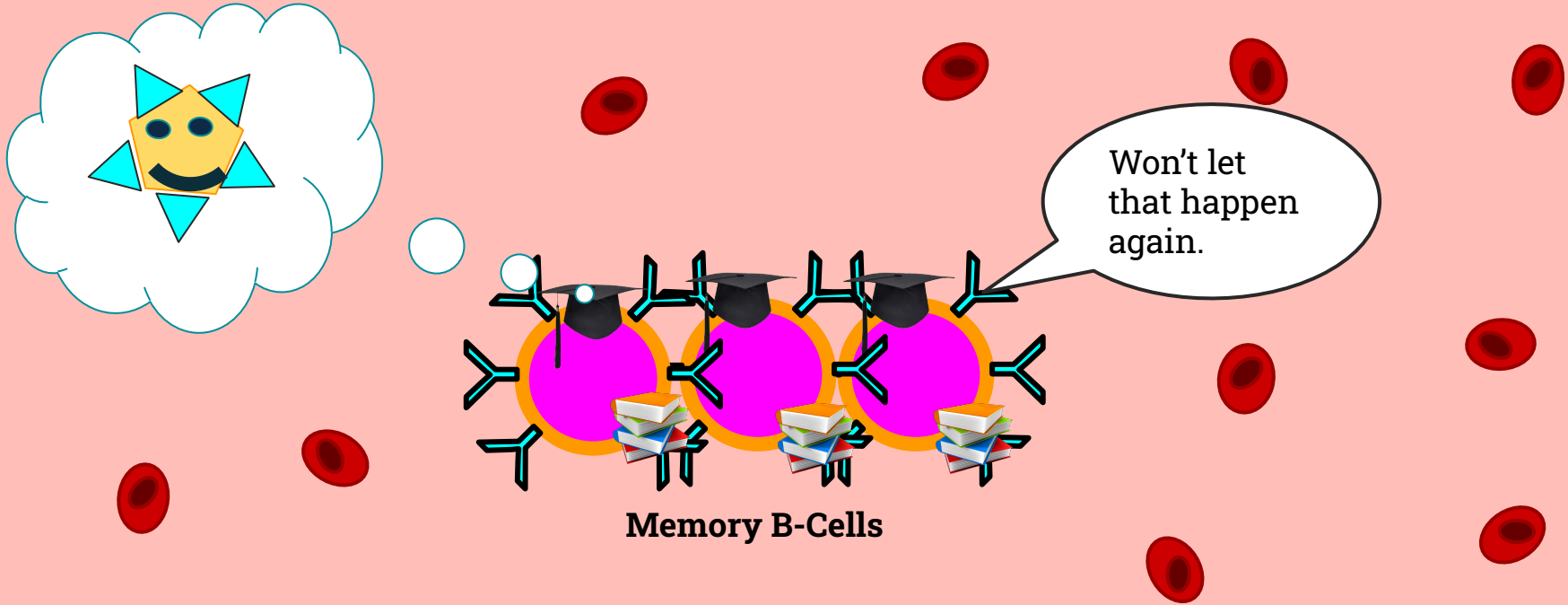




Note: Antibodies <u>DO NOT KILL</u> pathogens directly

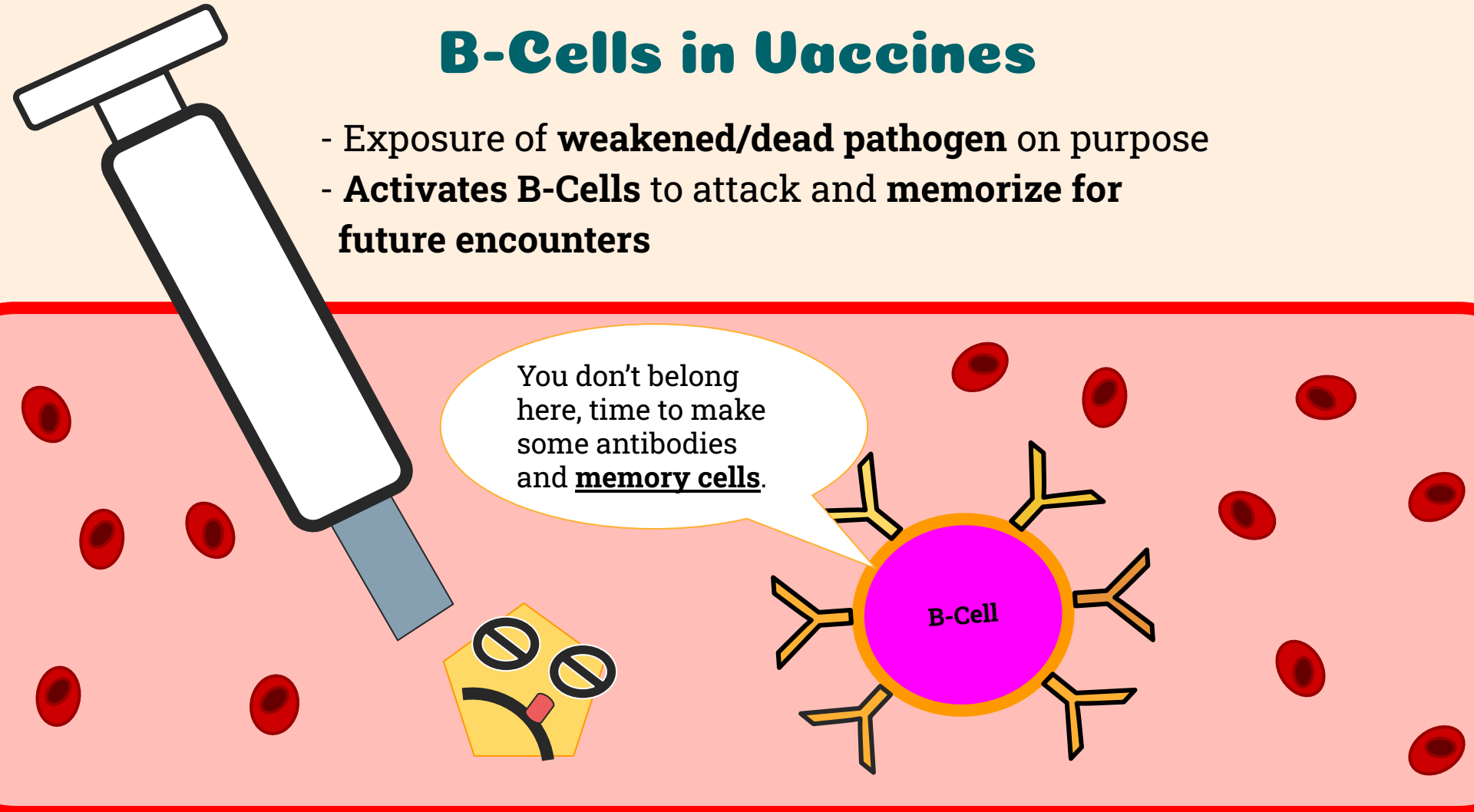
Memory B-Cells

- Remember the same pathogen
- Allow for quicker, stronger response when exposed again.



B-Cells in Vaccines

- Exposure of **weakened/dead pathogen** on purpose
- **Activates B-Cells** to attack and **memorize for future encounters**



Humoral Response Review

Antigen → B-Cell

Direct Activation

Helper T-Cell Activation

Antigen presenting cell → Helper T-Cell → B-Cell

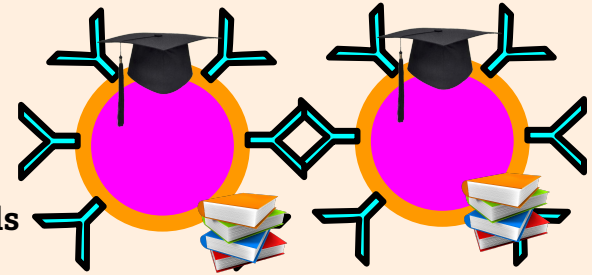
Clonal Selection

Plasma Effector B-Cells

Antibody Secretion

Primary Immune Response

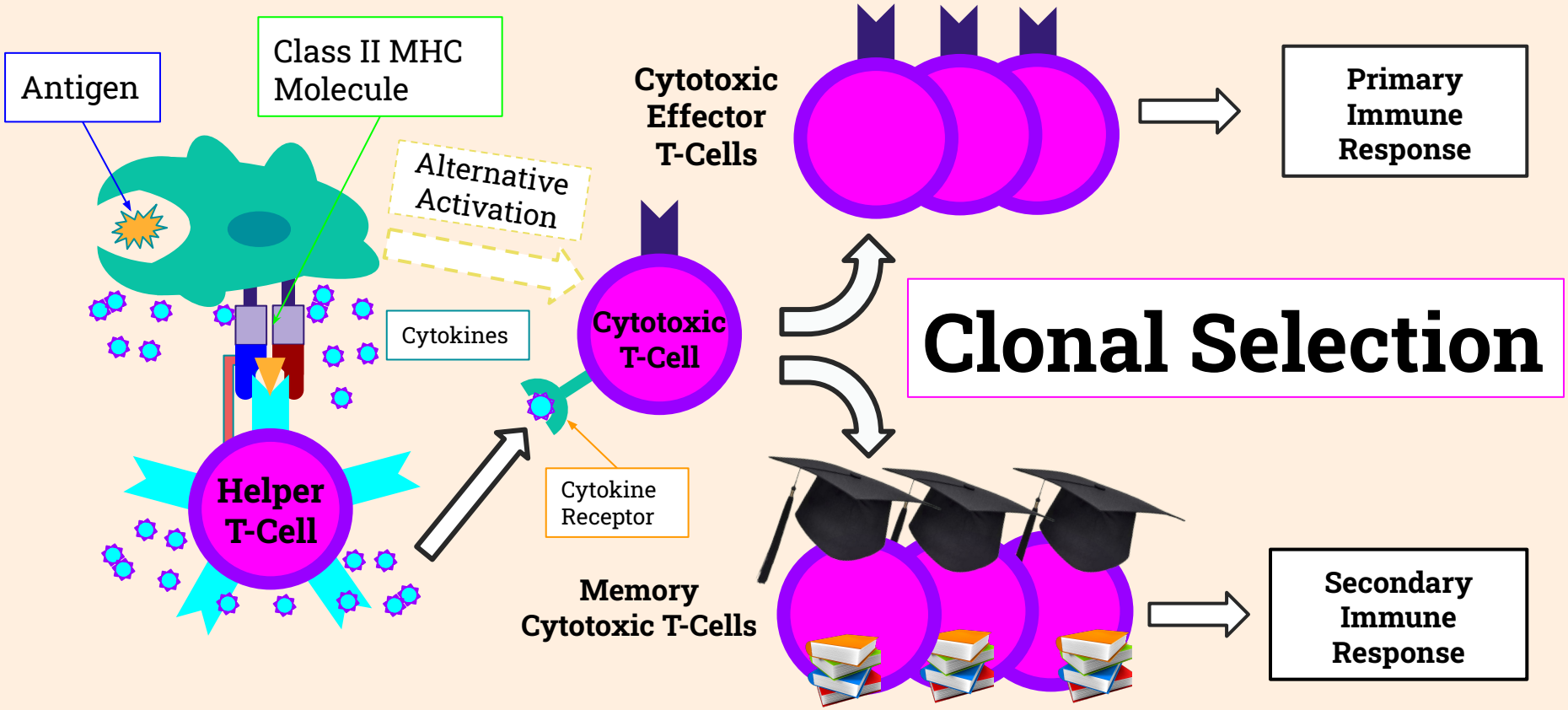
Memory B-Cells



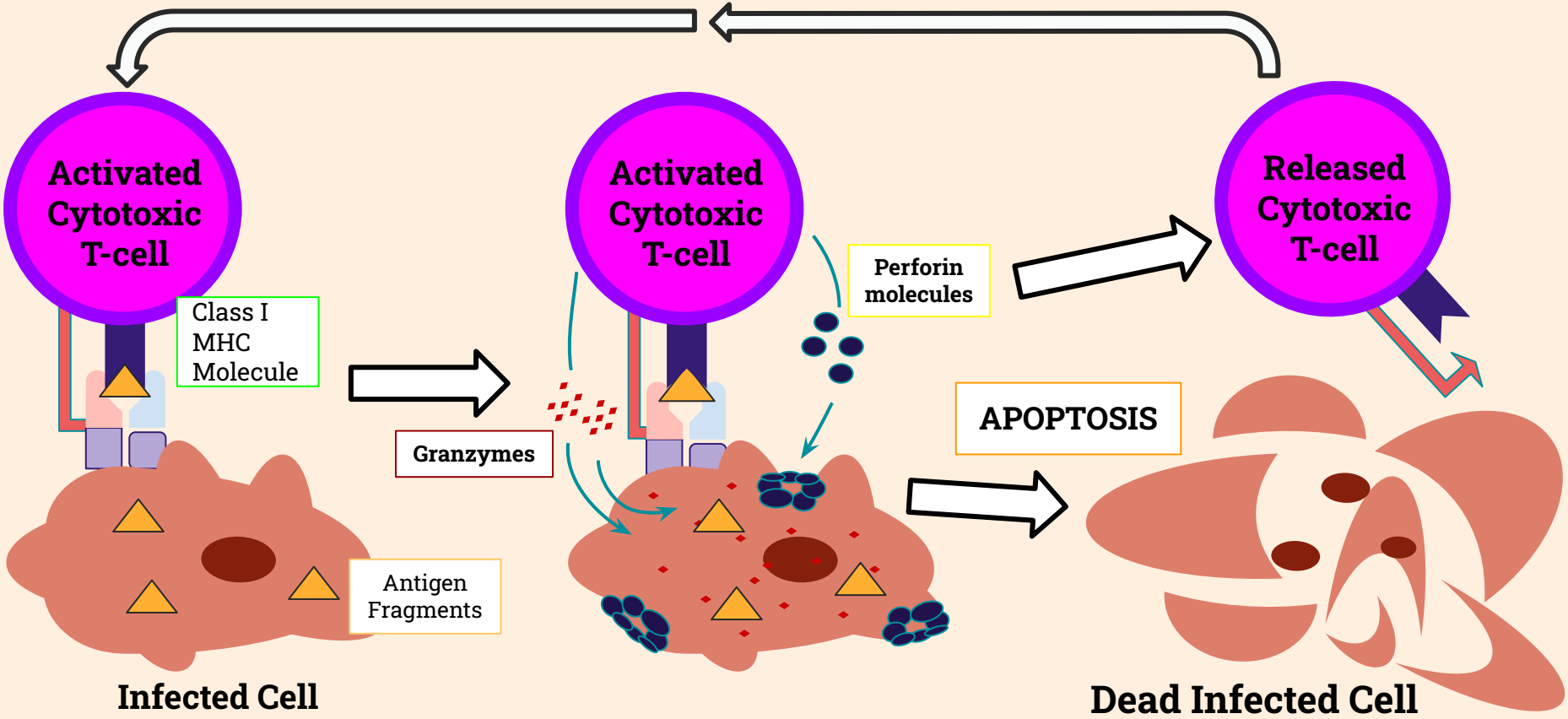
Secondary Immune Response

Cell-Mediated Response

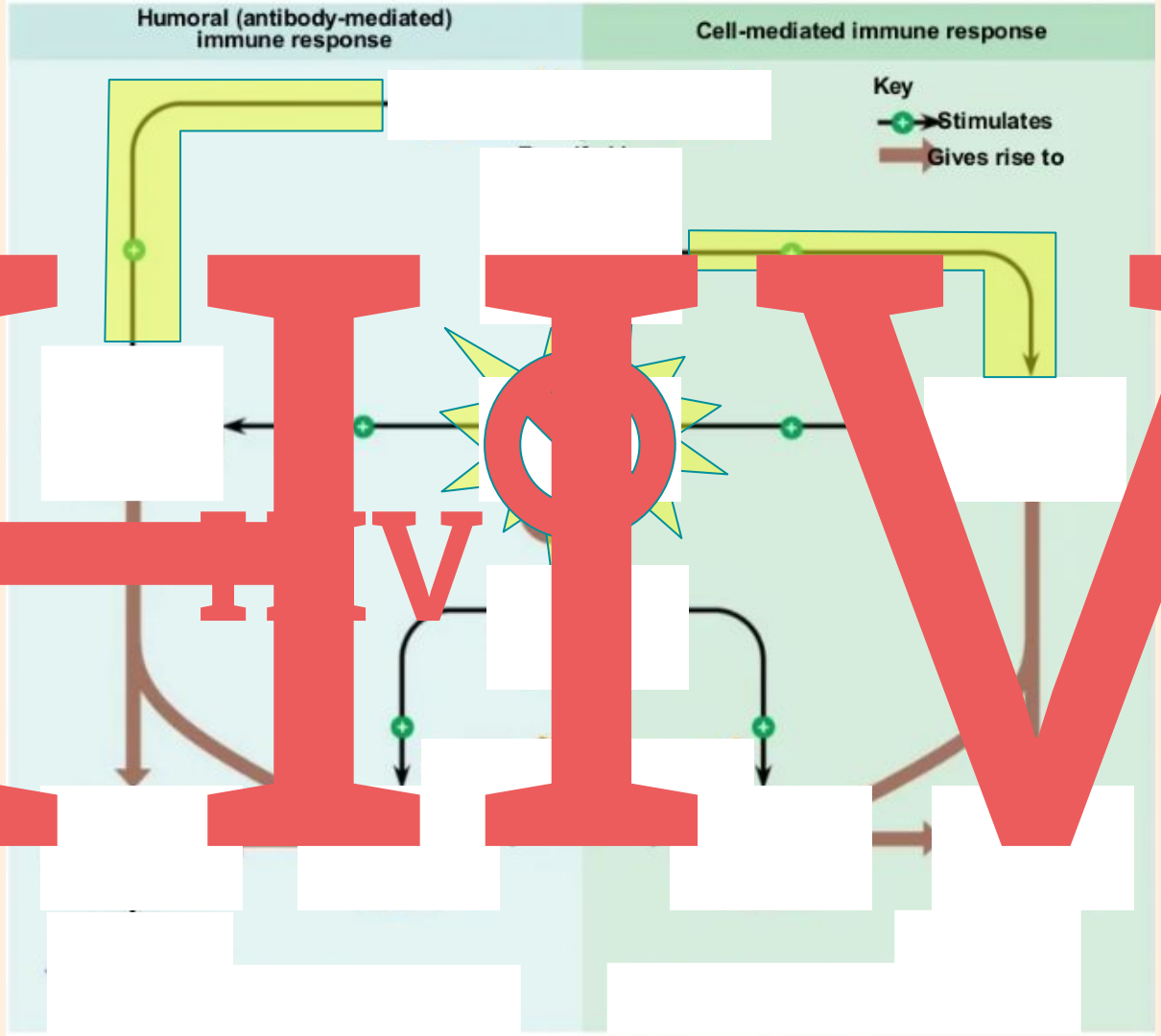
Cell Mediated Response



How a Cytotoxic T-Cell Kills



Adaptive Immunity Overview


Humoral (antibody-mediated) immune response
Cell-mediated immune response
Key
Stimulates
Gives rise to
HIV

Homework

- Watch the following Crash Course videos and take notes
- Take the Quiz