Biology Grade 8

Chapter 1: The Immune Response

Activity 4: Specific Immune Response

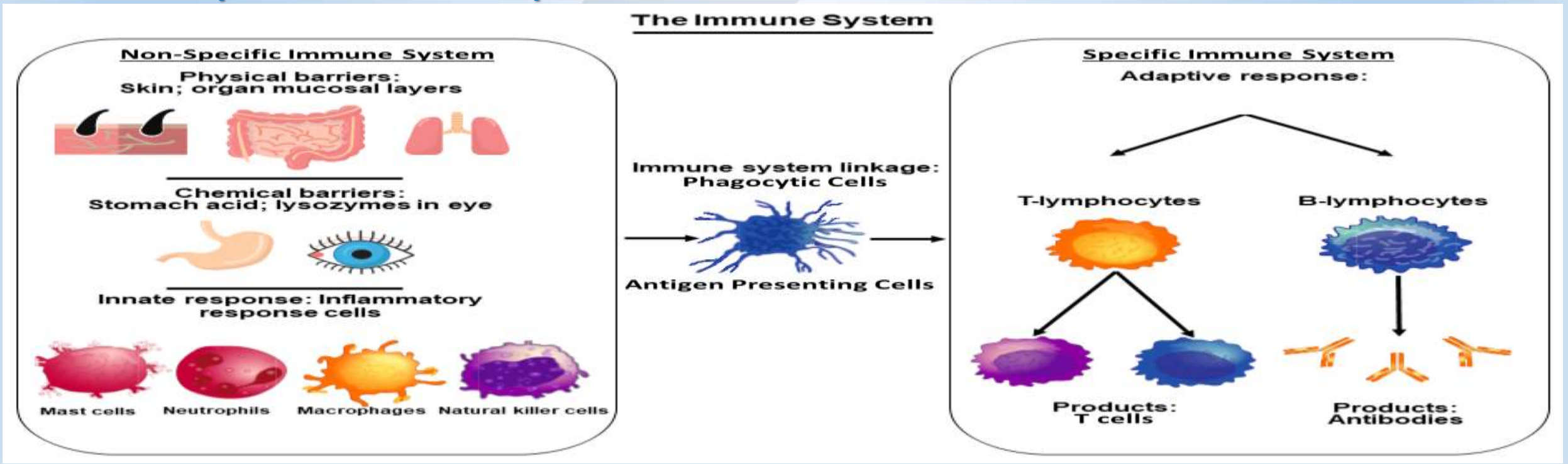
INSTRUCTOR: SUHAIB AUDI

Activity 4: Specific Immune Response

- It is an immune response **customized to the identity of the intruder.**
- It is carried out by **B and T lymphocytes**.
- It constitutes the third line of Defense against intruder.
- There are two types of a specific immune response:

✓ **Cell mediated specific immune response.**

✓ **Humoral specific immune response.**



Cell Mediated Specific Immune Response

- It is carried out by T-lymphocytes against cellular antigen.

❖ **Steps of the cell mediate the specific immune response done by T- lymphocytes to kill the target cell:**

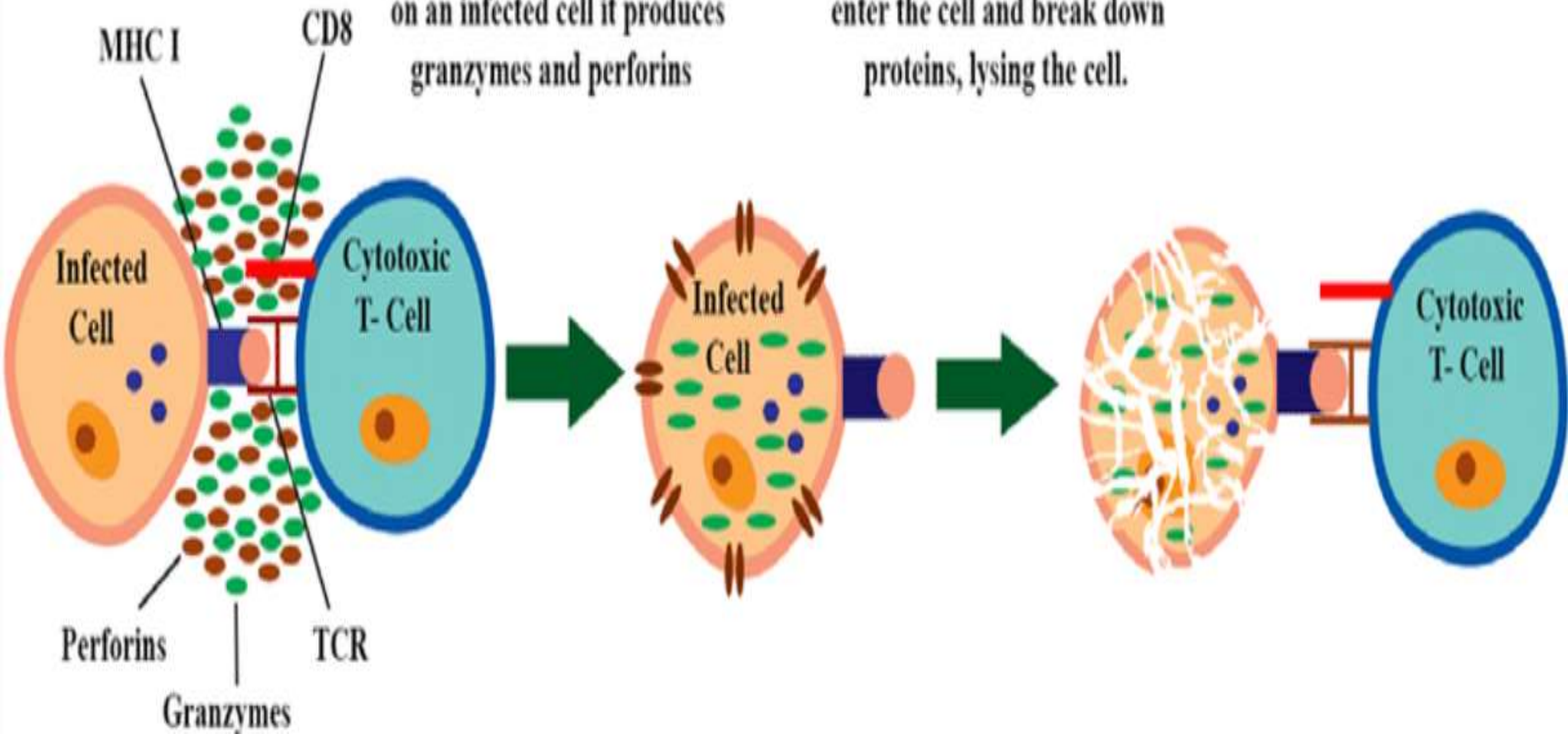
1. T-lymphocytes are attracted and activated by phagocytes (macrophages and granulocytes).
2. T-lymphocytes are then directed toward the target cell.
3. T-lymphocytes adhere to the membrane of the target cell.
4. T-lymphocytes secrete an enzyme called **perforin**, which perforates (creates pores in) the membrane of the target cell.
5. T-lymphocytes also secrete another enzyme called **granzymes**, which enter through the pores and induce cell death.
6. Finally, the phagocytes (macrophages and granulocytes) **phagocytose** the lysed (broken down) target cells.

Note: Graft rejection is an example of the cell mediated specific immune response.

CD8+ T Cells

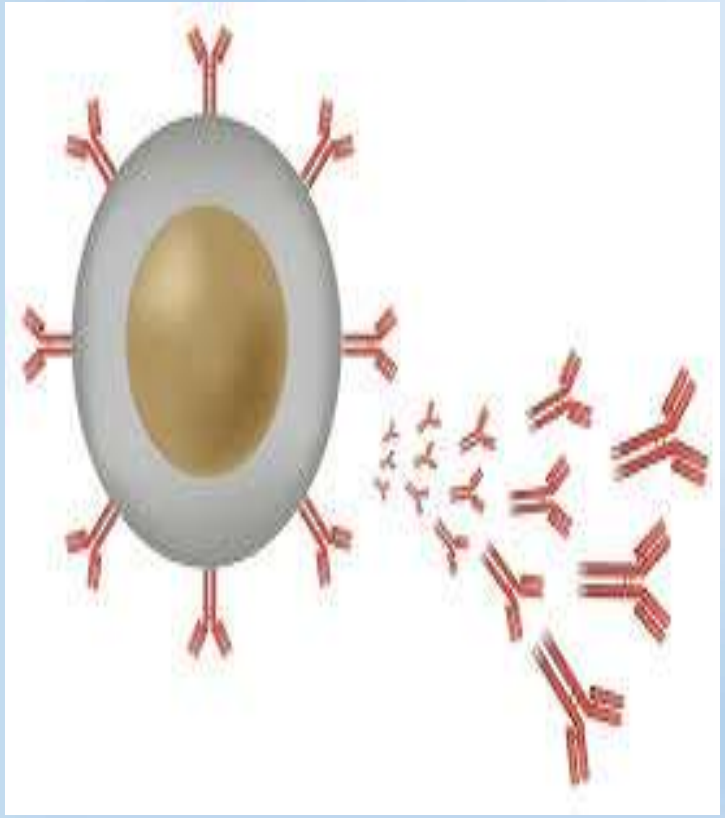
When a cytotoxic T cell interacts with the MHC I epitope complex on an infected cell it produces granzymes and perforins

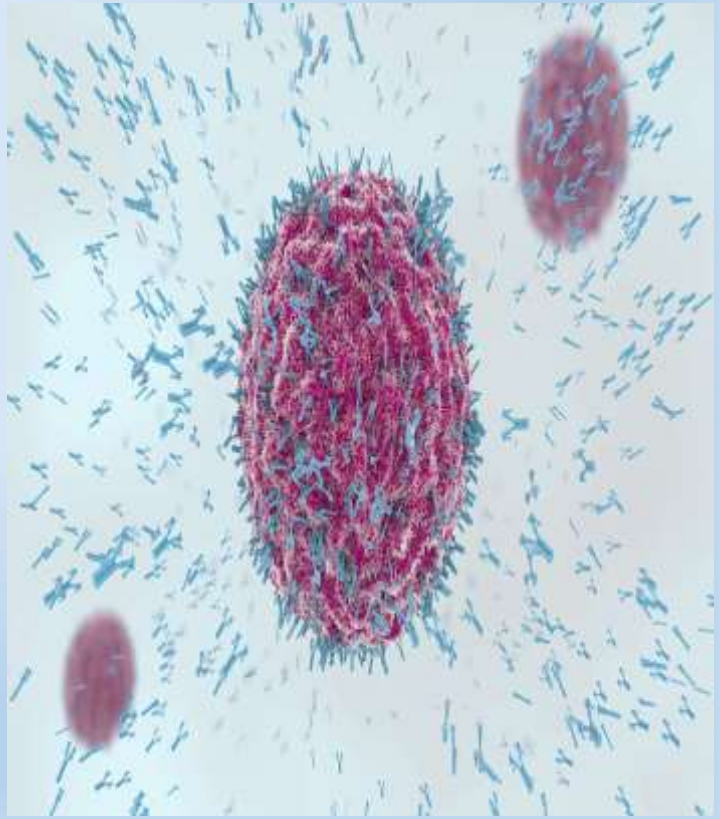
The perforins form pores in the plasma membrane. Granzymes enter the cell and break down proteins, lysing the cell.



Humoral specific immune response

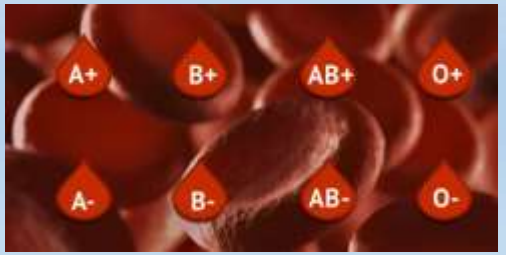
- It is characterized by the secretion of **antibodies**.
- Its actor cells are **B- lymphocytes**.
- **Blood transfusion is the best example to study humoral specific immune response.**



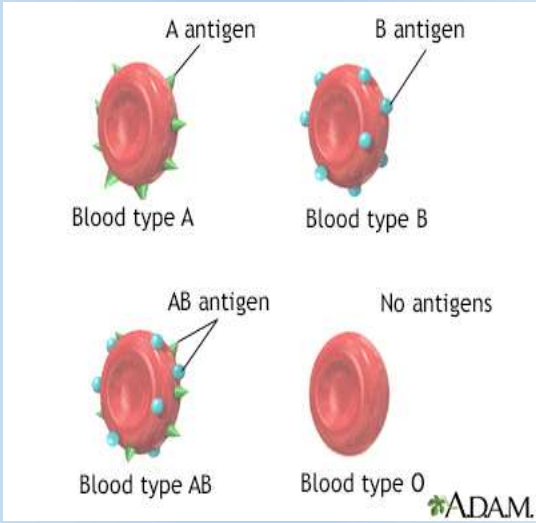


- **A B O system**

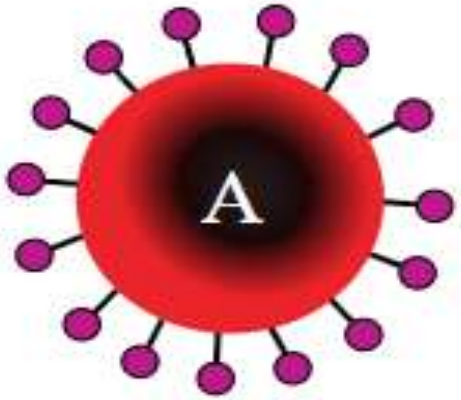
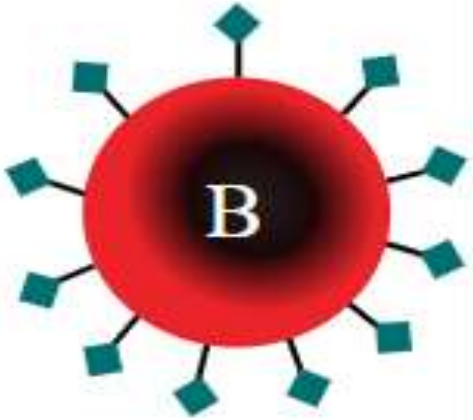
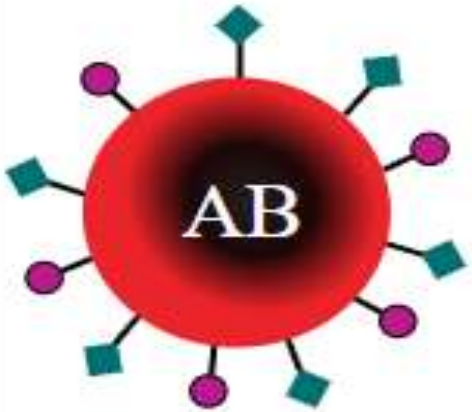
There are four types of a blood group → A, B, AB, O



- Blood groups are determined by their **antigens and antibodies**.



- The blood group of an individual is determined by the presence or the absence of a **specific antigen (agglutinogen)** on the membrane of the Red Blood Cells.
  - There are two types of antigens (agglutinogen):
    - antigen A and antigen B.
- In the **plasma** of each individual, there are **innate antibodies** (present since birth) called **agglutinins**.
  - There are two types of **antibodies (agglutinin):**
    - anti-A antibodies and anti-B antibodies .

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in plasma	 Anti-B	 Anti-A	None	  Anti-A and Anti-B
Antigens in red blood cell	 A antigen	 B antigen	 A and B antigens	None

❖ Blood Transfusion

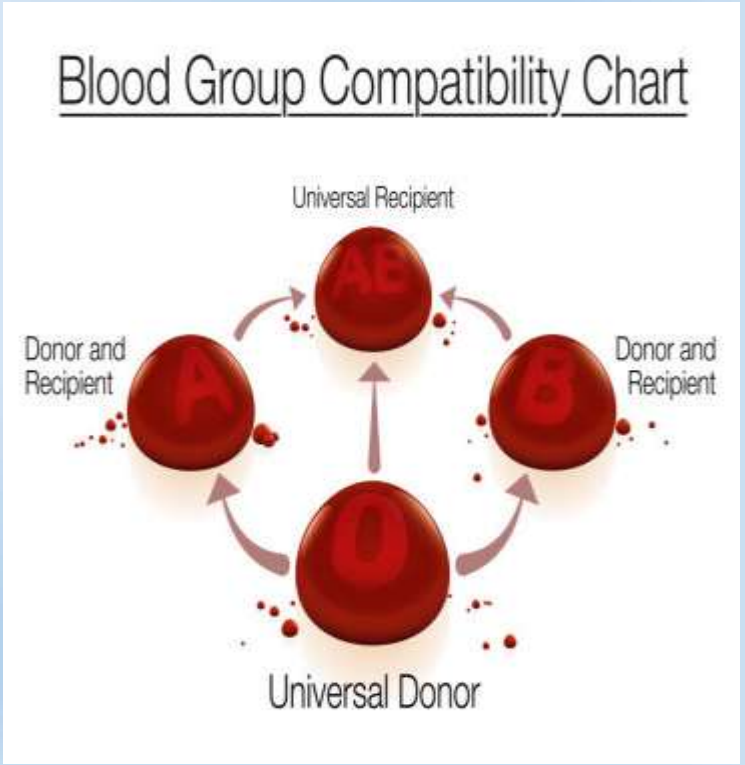
- It is the transfer of a blood from the donor to the recipients.
- Note: in blood transfusion we must **indicate that donor's antigen** and **the recipient's antibodies**.
- Rejection of blood transfusion is a due to the **recipient's anti-bodies.**
- A blood transfusion may be **rejected** if the **recipient's antibodies attack the donor's antigens**.

❖ Agglutination

It is a clumping (cluster) of a Blood that result from the **binding of antibody to its corresponding antigen**.

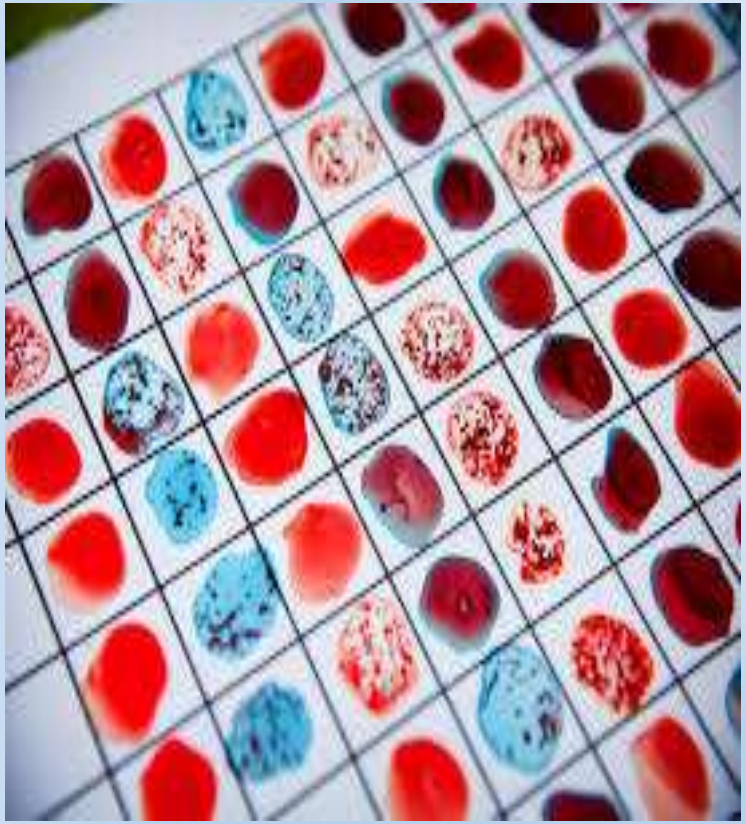
a. No agglutination

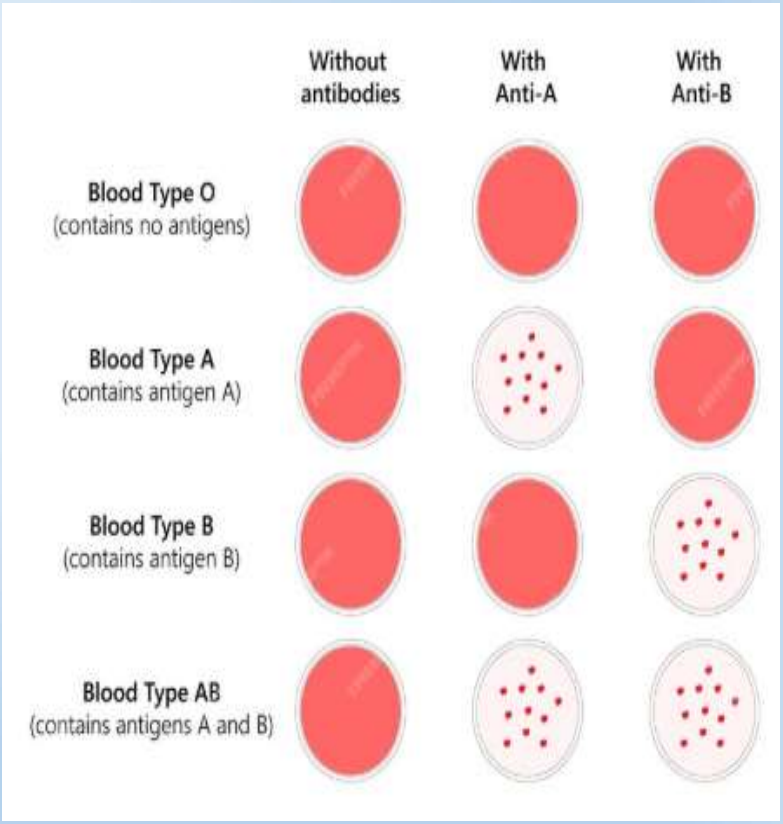
b. Agglutination



❖ Blood Group Test

- Blood group test is made to know the blood group of an individual by knowing the antigens that are found in his/ her blood.
- Two antibodies anti-A and anti-B are added to two blood drops from an individual.





Example:

In the framework of testing blood group of two persons X and Y, the following two tests were done:

Test 1: serum test (for Mr. X): We add a drop of the serum test to a drop of red blood cells suspension of blood X.

Test 2: red blood cells test (for Mr. Y): We add a drop of red blood cells suspension to a drop of serum of Y.

In each test, we mixed two drops and observed the state (agglutinated or not) of red blood cells.

The results of both tests were done in the two blood samples that are shown in the following tables:

	Add Serum containing	
	Anti-A	Anti-B
Red Blood Cells of Mr.X		

Agglutination

No Agglutination

	Add Red Blood cells have antigens:	
	A	B
Serum of Mr.Y		

	Add Serum containing	
	Anti-A	Anti-B
Red Blood Cells of Mr.X		

Agglutination

No Agglutination

Serum of Mr.Y	Add Red Blood cells have antigens:	
	A	B
		

a. Give the significance of the obtained agglutination in each test.

Red blood cells of Mr. X agglutinated with serum of anti-A but not with anti-B, this signifies that cells of blood Mr. X **contains antigen A.**

The serum of blood Mr. Y agglutinates with red blood cells A but not with B, this indicates that serum of Mr. Y **contains anti-A.**

b. Conclude the blood group of each person.

We conclude that blood group of X is A and that of Y is B.

Application 1:

A blood transfusion is performed between a donor individual whose blood group is A to a recipient individual whose blood group is B.

1. Specify the antigens of both the donor and the recipient.

The donor has antigen A because his blood group is A while the recipient has antigen B because his blood group is B.

2. Indicate the antibodies of both the donor and the recipient.

Donor: anti-B Recipient: anti-A

3. Will this blood transfusion succeeds? justify.

The donor whose blood group is A has **antigen A** on the membrane of his RBC. The recipient whose blood group is B has **anti-A** in his plasma.

In case of transfusion **anti-A will binds to the antigen A** and this will lead to **agglutination** leading to the **rejection (failure)** of this transfusion.

Application 2:

Determine if jana that has a blood group A can receive a blood from Ahmad that has blood group O.

Ahmed has no antigen.

jana has anti-B in her blood .

so in case of a transfusion there is no agglutination.

Thus Jana can receive a blood from Ahmad.

Application 3:

Following a car accident Samir was rushed to the hospital he needed an urgent surgery.

1. Indicate the blood group that can be safely transfused to him. Justify.

Blood group O can be safely transfused to him because the blood group O is the universal donor meaning an individual of blood group O has red blood cells deprived of antigens therefore neither anti-A nor anti- B will fight it.

A blood group test was performed to Samir the results are summarized in the document below.

	Serum anti-A	Serum anti-B
Samir's drop of blood	-	+

+: Agglutination

-: No Agglutination

2. Determine the blood the group of Samir

The blood does not agglutinate with the serum anti-A , indicating that Samir **does not have antigen A on his RBCs**. However, the blood of Samir agglutinates with the serum anti –B, indicating that Samir **has antigen B on the membrane of RBCs.** Therefore, his blood group is B.

3. Farid whose blood group is **AB** wants to donate blood for his friend Samir the doctor refuses him. **Explain** the doctor decision.

Farid whose blood group AB **has both antigens A and B** on his RBCs.

Samir whose blood Group is B has in his plasma **anti-A.**

so Anti-A antibodies will bind to the antigen A causing agglutination, as a result transfusion will be **rejected,** that's why the doctor refused him.

4. Identify the nature type of the immune response involved in the rejection of blood transfusion.

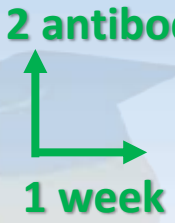
Since the antibody play a role in the rejection of blood transfusion.
Therefore, the immune response is a **humoral specific immune response.**

Exercise 1:

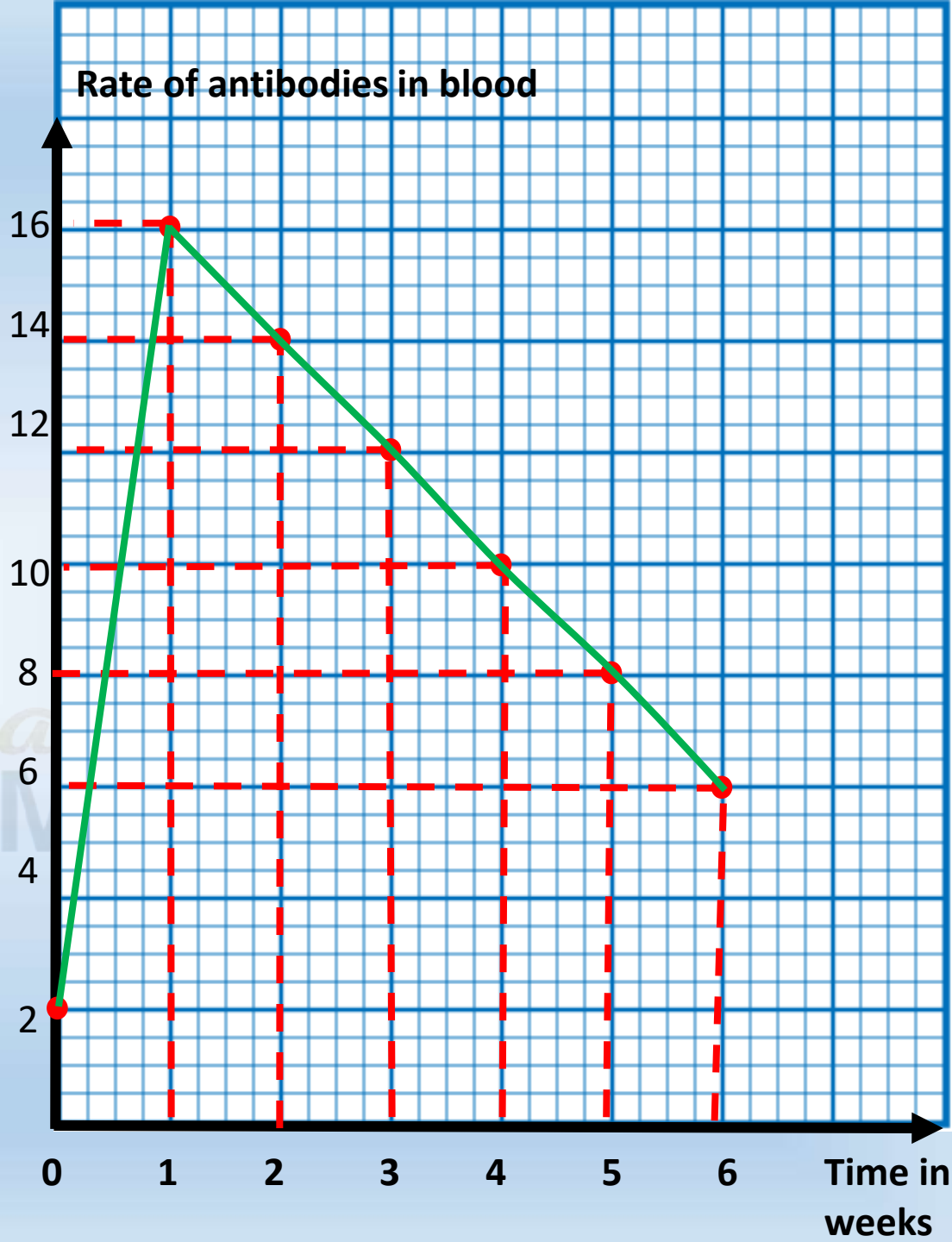
The table below shows the evolution of the antibodies anti-A of a mouse after its injection by antigen "A" at time 0:

Time (in weeks)	Rate of antibodies in blood
0	2
1	16
2	14
3	12
4	10
5	8
6	6

Scale:



Title : A graph showing the variation of the Rate of antibodies in blood as a function of the Time in weeks.



1- Draw the corresponding graph.

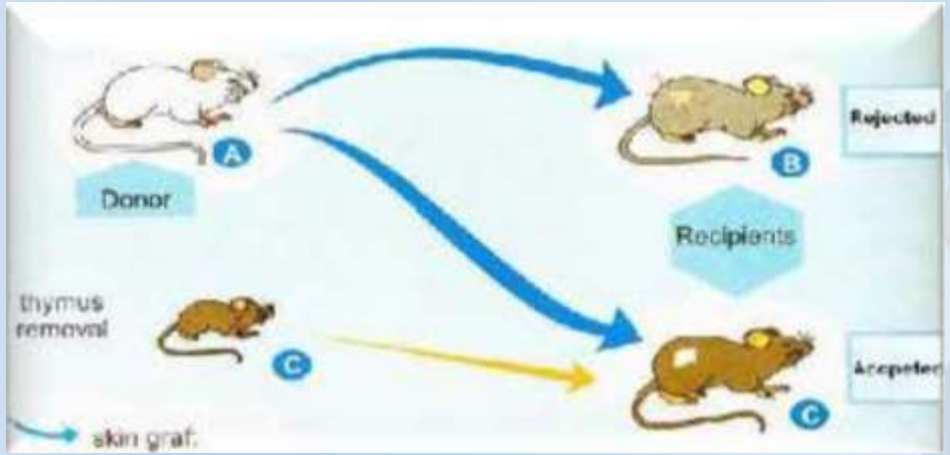
2- Analyze this graph. Conclude the type of immune response.

After the injection of Ag A, as the time **increases** from 0 to 1 week the rate of antibodies in blood **increases** fro 2 to 16. Then, as the time **increases** from 2 weeks to reach 6 weeks the rate of antibodies **decreases** from 16 to 6 .

Humoral specific immune response

Exercise 2 :

A skin graft experiment is performed among three mice: A, B and C of different strains. The thymus of mouse C was removed at birth. The results are illustrated in the figure below:

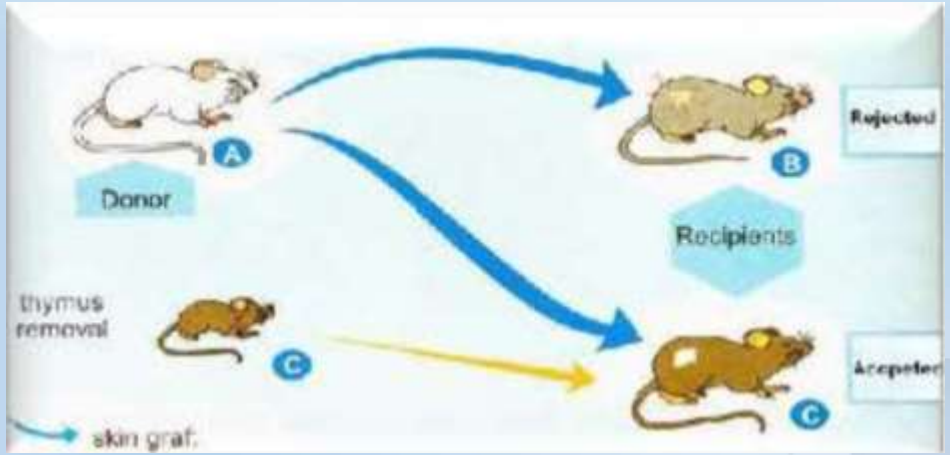


a. Describe both experiments.

Mouse A donates skin to mouse B and for mouse C which had its thymus removed previously, mouse B rejected the graft while mouse C accepted the graft.

b. Analyze the experimental results.

The skin graft between **mouse A and mouse B was rejected, while** the skin graft between **mouse A and mouse C that has no thymus was accepted**.



c. Derive a conclusion concerning the role of thymus.

We conclude that the thymus rejects the graft.

d. Determine the type of graft done in each experiment.

The three mice are of different strains, so the graft between A & B and A & C is allograft.

e. Specify the type of immune response in mouse B.

Cellular mediated specific immune response, since the T cells are involved in this response.

Exercise 3:

Sara is an eighth grader that had to skip school for a week due to a tonsils infection. When she went to the doctor, he told her that her tonsils look big and red and that she has to take a medicine for pain. The doctor told Sara that her immune system has started a response against the pathogen causing these signs to appear. If the symptoms persist more than three days, she will have to take a medicine (antibiotic).

1. Did Sara's body recognize the pathogen as self or non-self? Justify.

Non self, since her immune system started an immune response against the pathogen.

2. Give the name of the immune response (IR_1) that happened in Sara's body. Identify its type.

Inflammatory response. It is **non-specific immune response** since it is not mediated against specific antigen but against all pathogens that enter the body and **doesn't depend on the identity of the pathogen.**

3. State its symptoms that are mentioned in the text and indicate their causes.

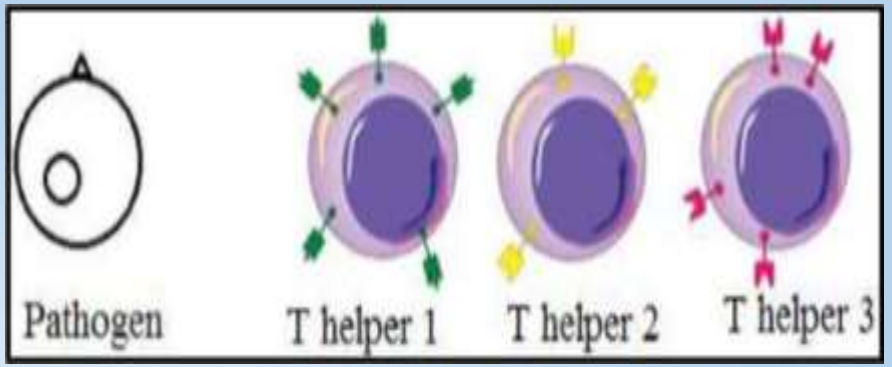
Her tonsils look big and red, since all immune cells migrate to these locations to fight the pathogens.

4. The above response will allow macrophages to leak to the area of infection. Give the name of the mechanism done by macrophages against this pathogen. **Phagocytosis**

Another immune response (IR2) starts in Sara's body when the pathogen is identified and T killer cells are activated.

5. Referring to the figure, specify the T helper that can recognize the given pathogen.

T helper 3, since the receptor of this T cell can bind to the antigen of the pathogen.



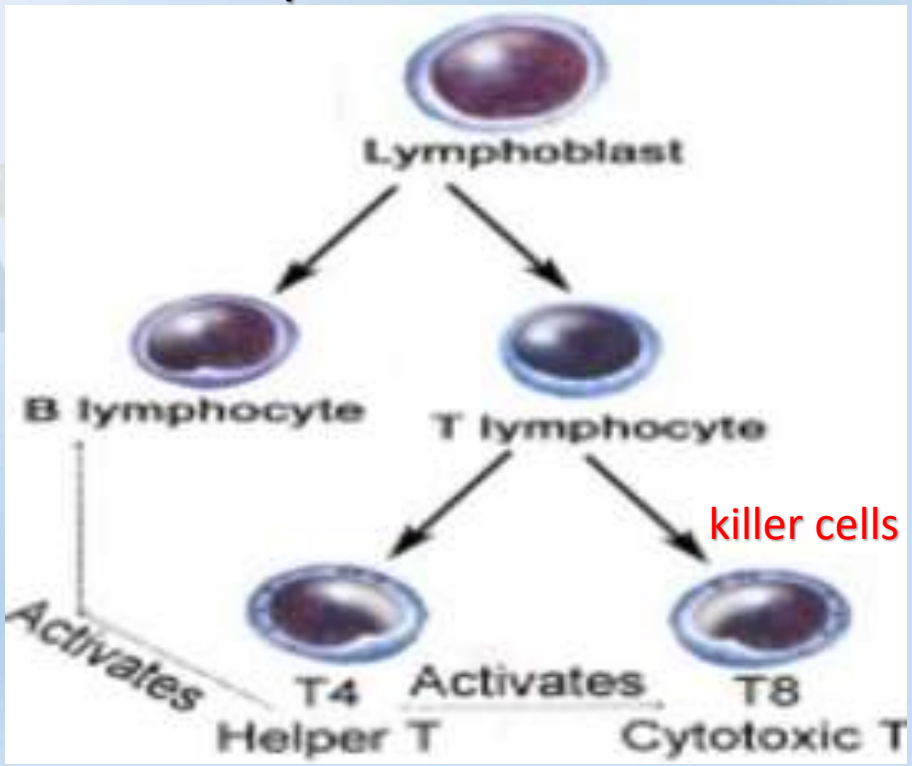
After recognizing the pathogen, T-helper activates T-killer cells that perform another immune response (IR2)

6. Indicate how T-killer cells are activated.

T killer cells are activated by T helper.

7. Name this immune response.

Cell mediated specific immune response.



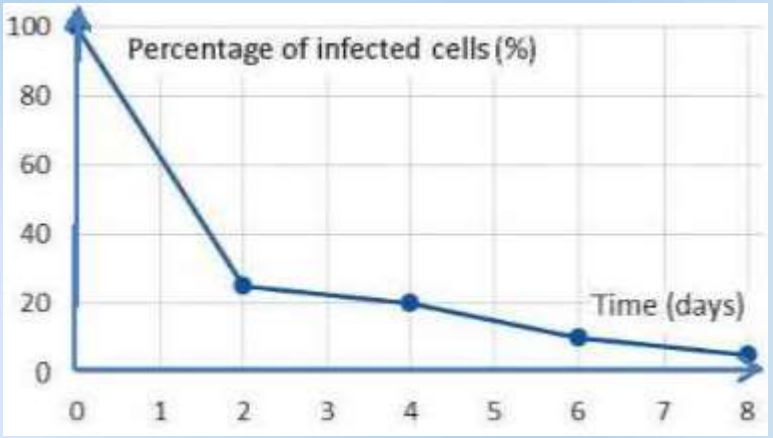
8. Referring to your acquired knowledge, fill in the missing word to complete the description of the immune response (IR2) done by the T-killer to destroy the pathogen.

The T killer binds with its ---receptor--- to the ---antigen--- of the pathogen. Then it secretes ---perforin--- that create pores in the infected cell's membrane. After that, ---granzymes--- enter the infected cell via pores. And with the help of other molecules, induce the ---lysis--- of the infected cell.

9. Compare between the two immune responses IR 1 and IR2.

Both immune responses defend the body against pathogens. But IR1 is rapid, local, non-specific (second line of defense) while IR2 is slow, not local, specific (third line of defense).

When T-killer starts acting, the % of cells infected by the pathogen changes according to the given graph.



10. Analyze the graph.

At time (0 days) the % of infected cells was 100%. Then this percentage decreases to 5% as time increases to 8 days.

Sara will remain sick if the number of infected cells is greater than 30%.

11. Referring to the text and the graph, do you expect that Sara is going to need the medicine (antibiotic) that the doctor mentioned? Justify.

No, since the percentage of infected cells decreased to 5% **less than 30%.** So she is not sick and there is no need to medicine.