

ACTIVITY 3 BODY DEFENDERS

In this activity, the student will model specific and non-specific defenses against infectious organisms.

Background

The immune system deploys different types of defenses in protecting the body against disease-causing organisms. One type is non-specific, affecting a wide variety of pathogens. Key non-specific defenders are the phagocytes. Latin for “cell-eater”, phagocytes are white blood cells that travel around the circulatory system gobbling up and digesting debris, pathogens, infected or worn out cells. Some phagocytes migrate to the lungs and certain other organs where they enlarge into macrophages (“big eaters”). Each of these cells is capable of consuming more than 100 bacteria before dying from the effect of the enormous pathogen meal.

In addition to the non-specific defenses, the immune system has the ability to target a particular pathogen. One of these specific defense mechanisms is the antibody-mediated response, which uses phagocytes, as well as B-cells and helper T-cells. B-cells are white blood cells that mature in the bone marrow, and helper T-cells develop in the thymus. After a phagocyte digests a pathogen, it displays antigens from the infectious organism on its surface. Antigens are chemicals that elicit an immune response. In this case, they stimulate helper T-cells to instruct B-cells to make antibodies. The antibodies bind to the antigens, and phagocytes engulf and destroy these complexes. Phagocytes are not the only cells that can “present” antigen to T-cells. B-cells can also display antigens to helper T-cells. The T-cell then instructs the B-cell to make antibodies.

Body Defenders is based on activities developed by Tory Brady for The Exploratorium in San Francisco, California.

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Learning Objectives

The student will:

1. Comprehend the role of the immune system in detecting and eliminating pathogens.
2. Act out non-specific and specific defenses against infection.

Materials

1. A piece of colored paper or cloth
2. Antigen and antibody template sheets (student version)
3. Colored railroad board or poster board
4. Scissors
5. Large plastic garbage bag

Procedure

Non-specific Defense

1. Tell the class they will be acting out a phagocyte, a white blood cell that is part of the body's immune system.
2. Have the students form a circle, holding hands, facing out. This represents the outer, hydrophilic layer of the phagocyte's bilayer cell membrane.
3. Take 3 or 4 students and have them form a smaller, inner-facing circle within the cell, representing a lysosome full of digestive enzymes (lysozymes).
4. The teacher will act out the role of a pathogen—bacteria or virus—which will be ingested by the phagocyte. He or she holds a piece of colored paper or cloth to represent the pathogen's antigen.
5. As the pathogen nears the phagocyte, the students in that area of the membrane “engulf” it by forming a circle around the pathogen without letting go of their joined hands.
6. After the circle of students encloses the pathogen, they quickly break off from the outer circle and head towards the center. The outer circle reconnects. The pathogen is now **INSIDE** the white blood cell, but it cannot damage the phagocyte because the pathogen is surrounded by cell membrane (the small group of students that broke off from the outer circle).
7. Instruct the lysosome to migrate over to the encircled pathogen and fuse with it (have the lysosome circle join hands with the circle encapsulating the pathogen). The teacher should scream in agony and say that the lysozymes (digestive enzymes) are digesting him or her.
8. Next, the lysosome with the dead pathogen inside migrates to the cell membrane and joins with it. The pathogen is dumped out, but as it leaves, the pathogen gives the antigen to one of the students making up the cell membrane. Note: the presentation of the antigen on the cell membrane is the trigger that stimulates helper T-cells to alert the B-cells to make antibodies.

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Specific Defense

1. Prior to class, use the teacher version of the antibody templates sheets to create student versions. These sheets **SHOULD NOT** have a number on them. The number identifies which antigen binds to the antibody.
2. Describe the specific defense process and then divide the students into two groups—antigens and antibodies.
3. Have students cut Y-shaped antibodies out of one color of railroad board or poster board using the template sheets. Note: there are different shaped receptors at the ends of the Y, although the rest of the shape is the same from one antibody to another.
4. Instruct the other group to cut antigens out of different colors. Note: the protruding shape on the antigen is the epitope, or marker that complements the antibody's receptors.
5. Each student should have at least 2 antigens or antibodies.
6. Have students go around the classroom holding up their antigens. When an antibody recognizes a marker (epitope) on an antigen, he/she binds with it, and that antigen is inactivated.
7. Some antibodies will bind with two antigens at their two receptor ends, and these antigens may also be bound by other antibodies at other marker sites on the antigen. This creates an antibody/antigen “chain of agglutination”. Phagocytes are attracted to these complexes and engulf them. A student with the garbage bag acts as a phagocyte and gathers up the antigen/antibody complexes.

Extension Activities

- *Visual Arts:* Create models of different types of immune system cells.
- *Science:* Research how the immune system can cause autoimmune diseases.
- *Language Arts:* Create a story from the perspective of the immune system as it battles a disease.

Standards

National Science Standards, Grades 5-8

- Science Content Standard C: Students should develop understanding of structure and function in living systems.
- Science Content Standard F: Students should develop understanding of personal health

National Health Standards, Grades 6-8

- Standard 1: Students will comprehend concepts related to health promotion and disease prevention to enhance health.

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Web Sites

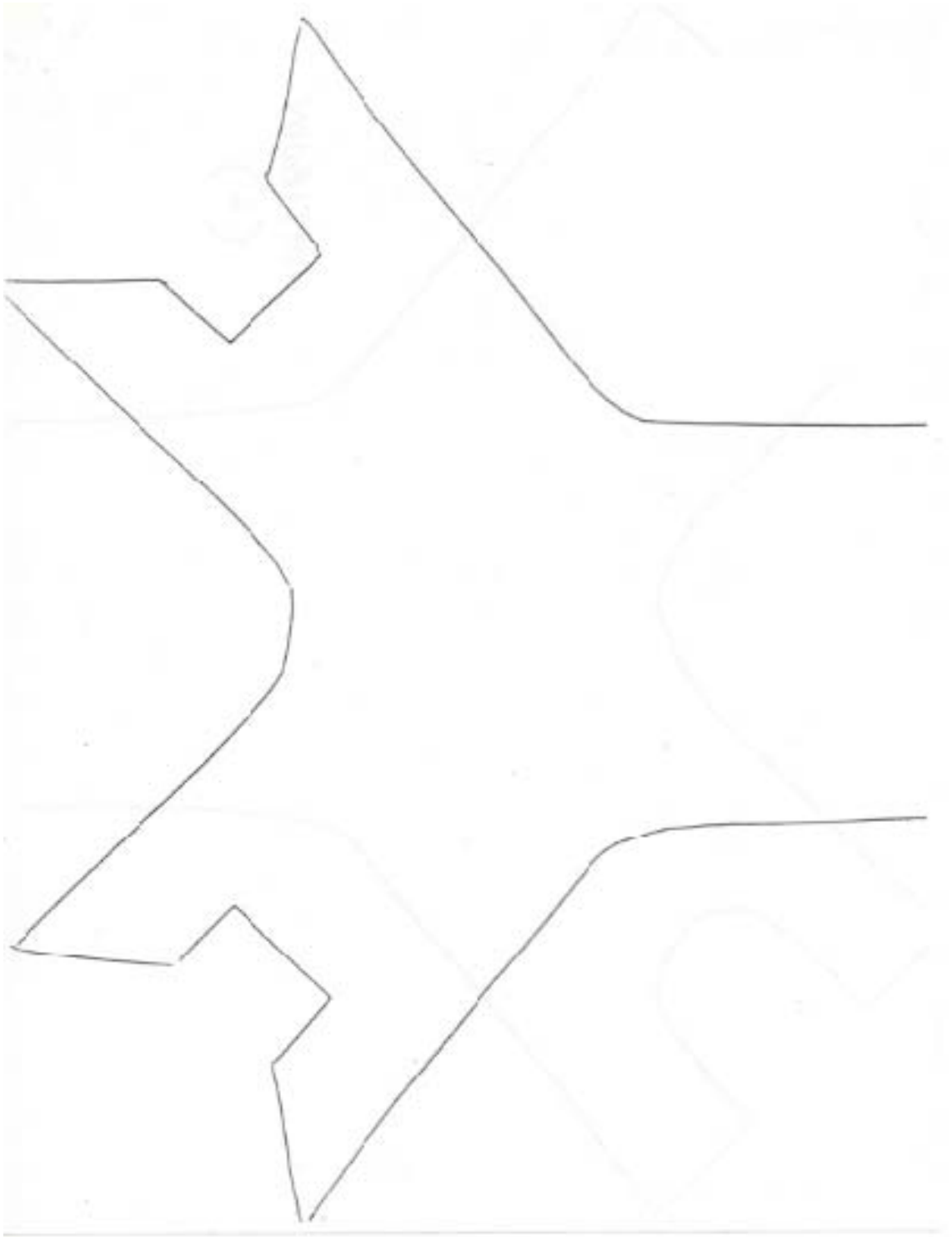
- About.Com: Understanding the Immune System
<http://thyroid.about.com/library/immune/blimm10.htm?terms=monocyte+and%20macrophage>
- The National Institute of Allergy and Infectious Diseases: The Immune System
<http://www.niaid.nih.gov/final/immun/immun.htm>
- Wikipedia: Macrophage
<http://en.wikipedia.org/wiki/Macrophage>

Curriculum Guides

Emerging and Re-emerging Infectious Diseases. National Institutes of Health Curriculum Supplement Series Grades 9-12. Publication No. 99-4645, 1999.

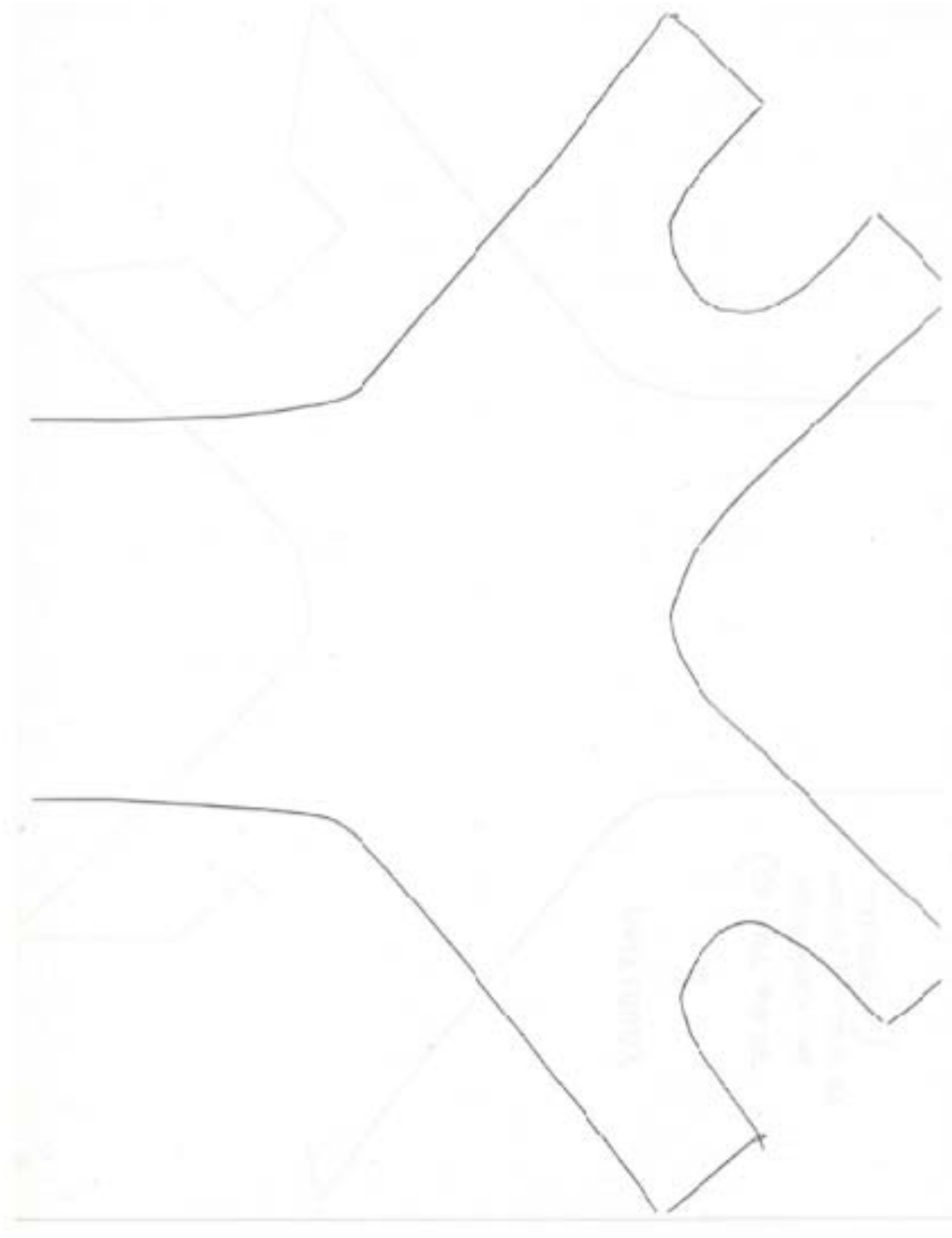
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Antibody 1 Template Teacher Version



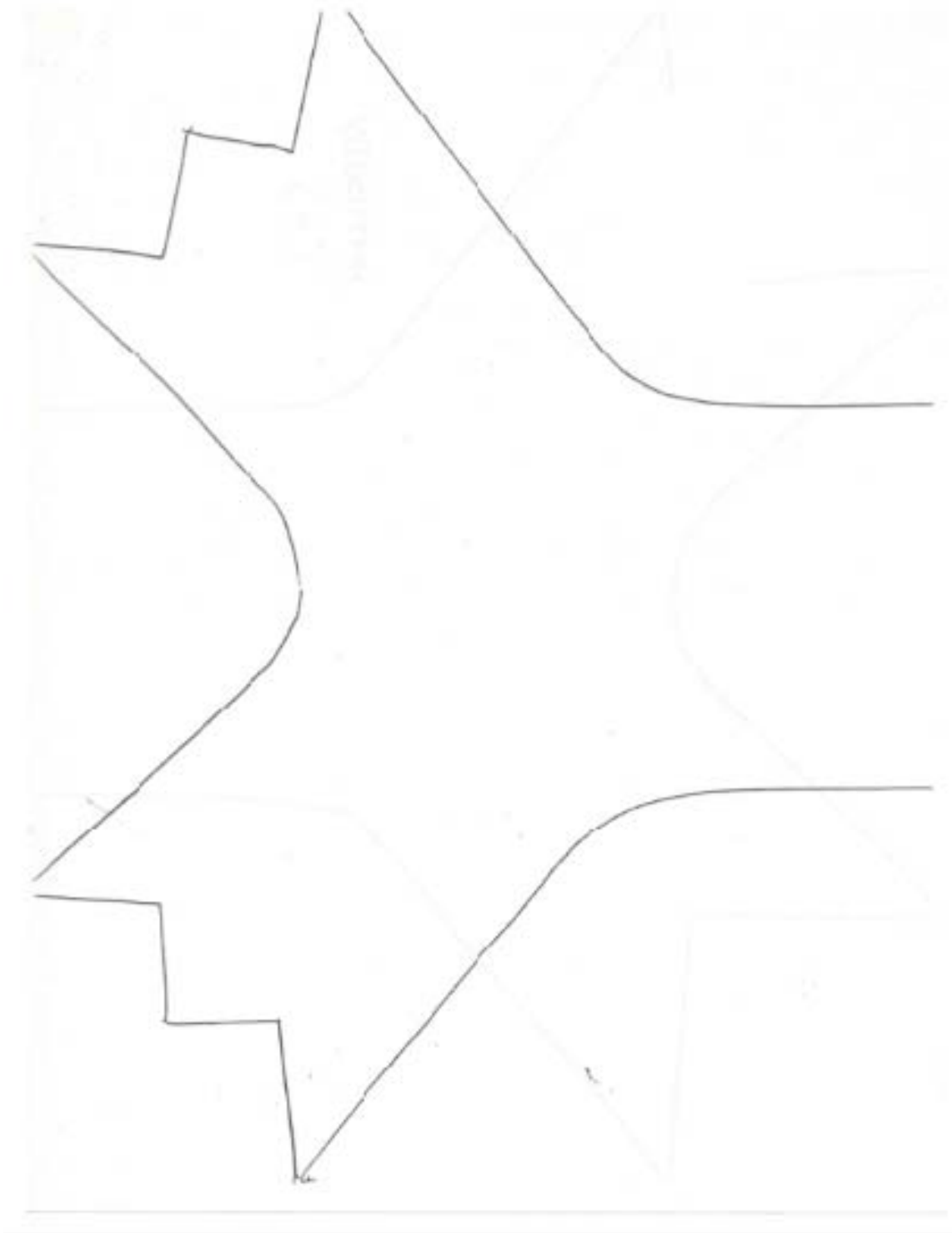
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Antibody 2 Template Teacher Version



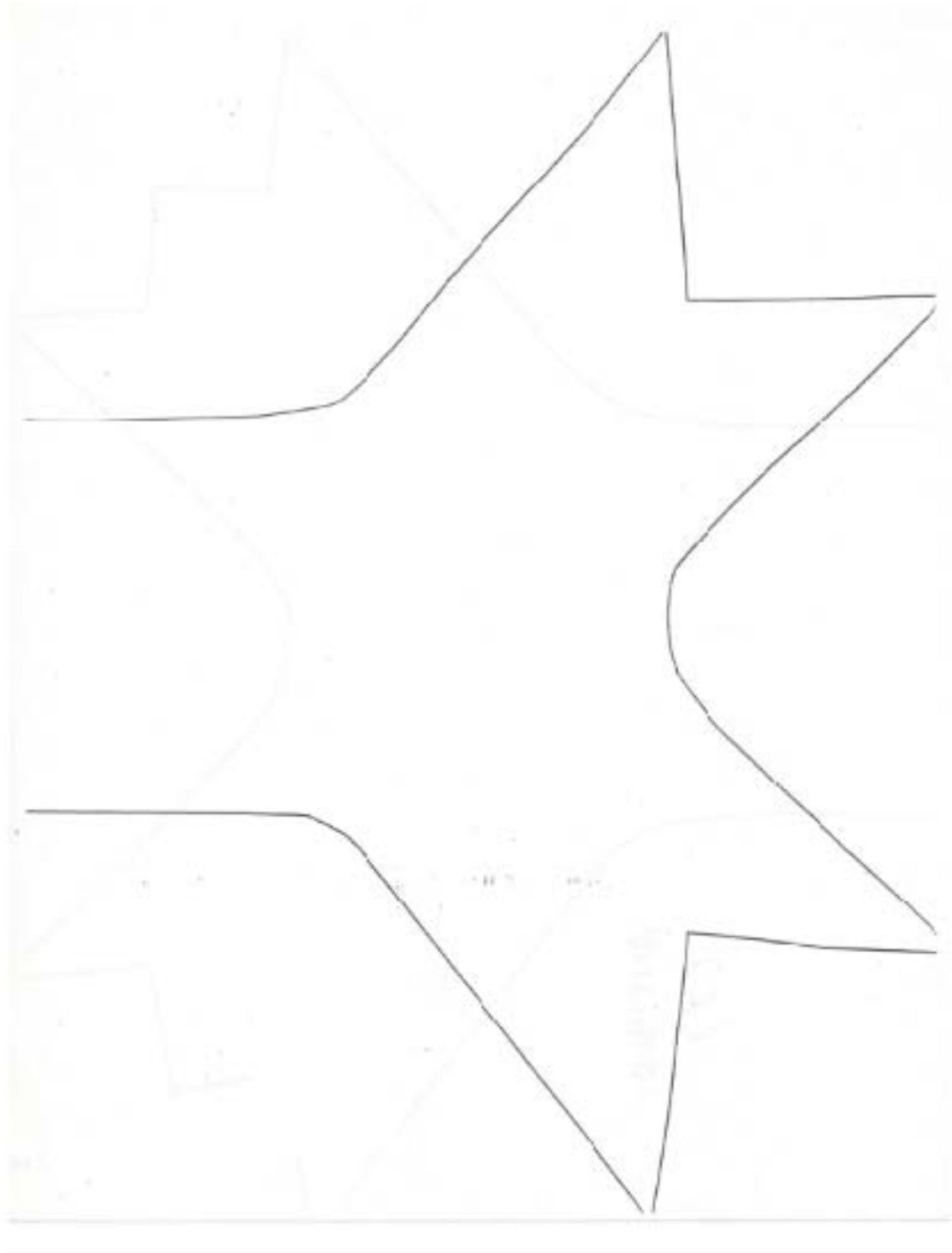
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Antibody 3 Template Teacher Version



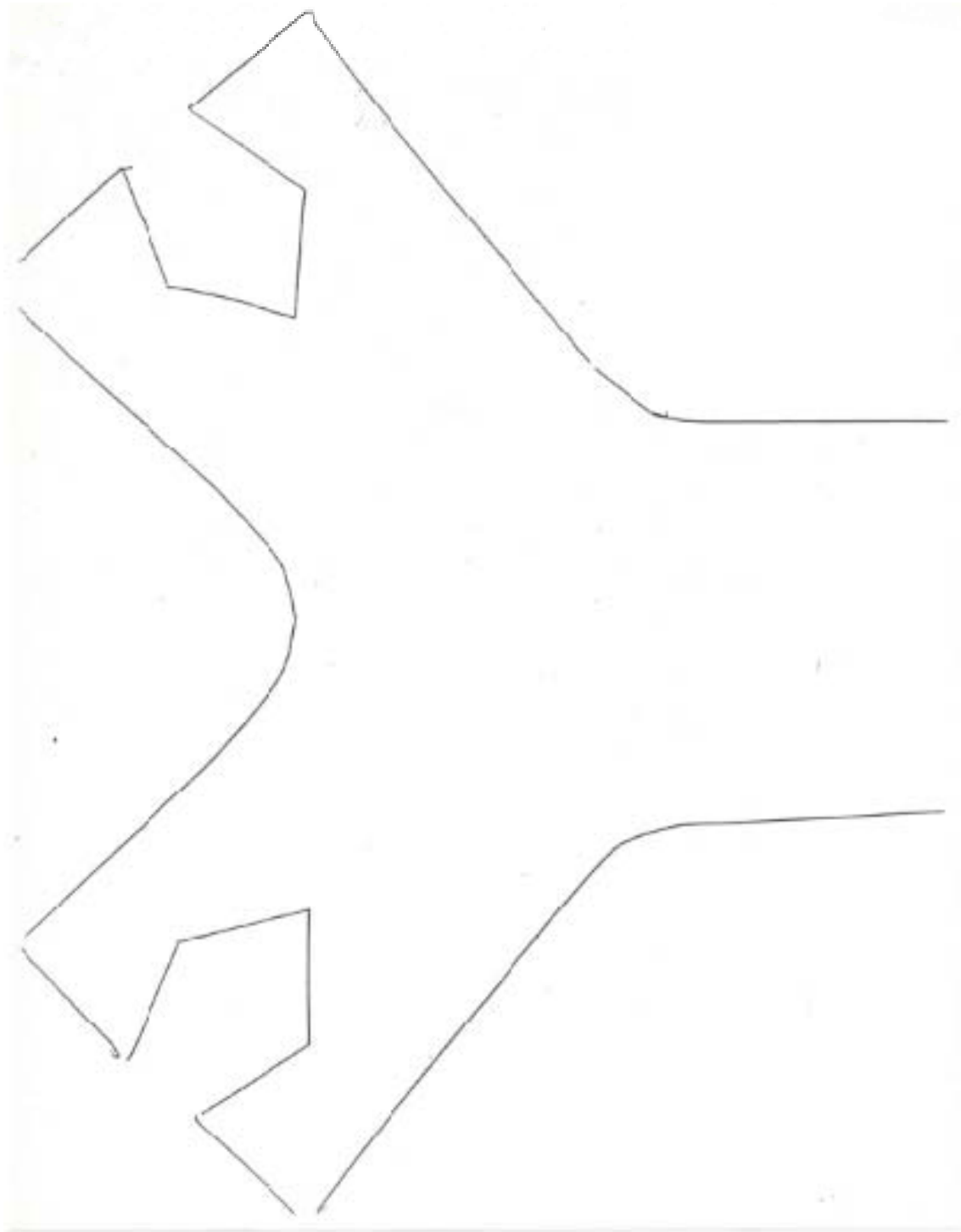
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Antibody 4 Template Teacher Version



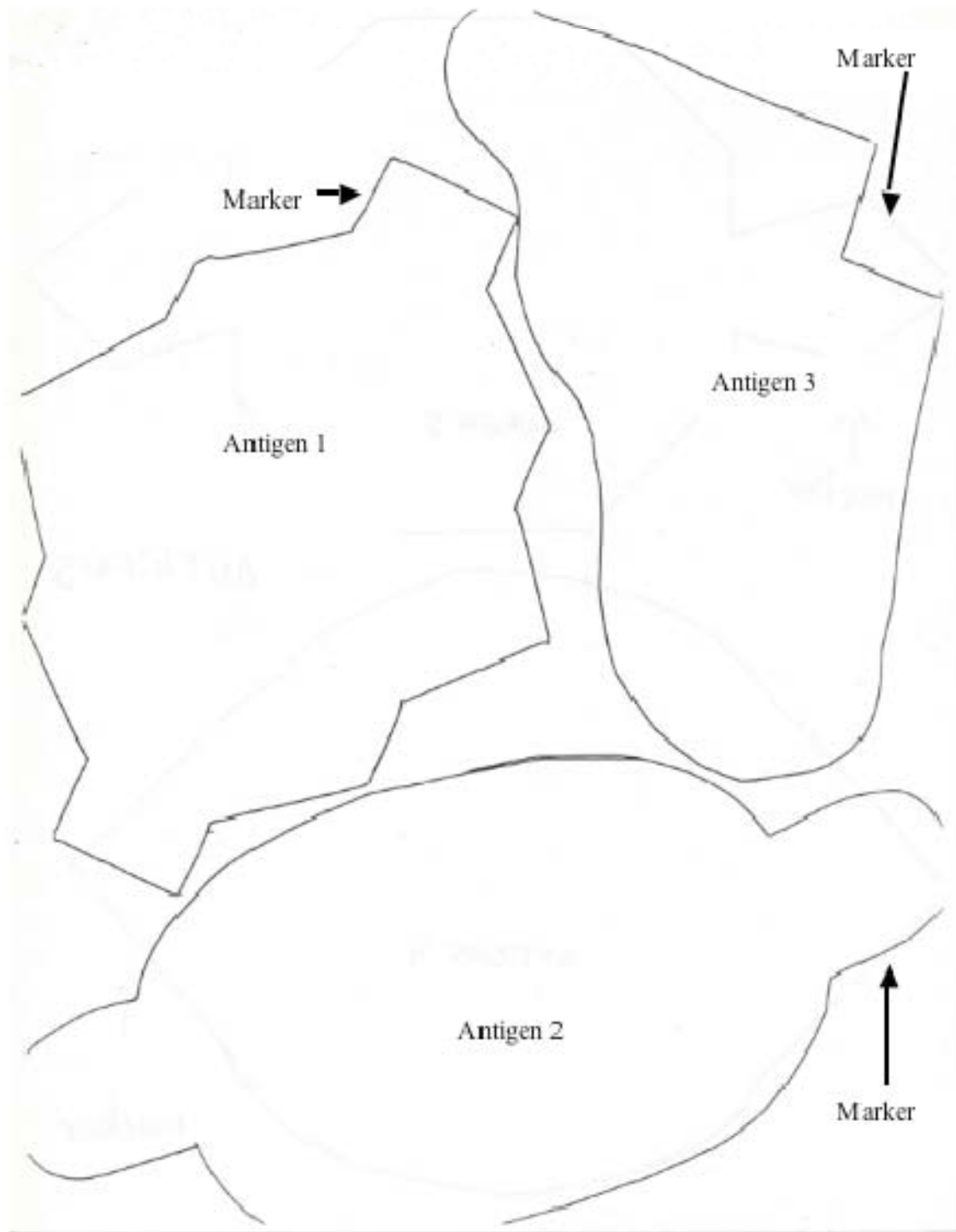
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Antibody 5 Template Teacher Version



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Antigen Templates



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Antigen Templates

