# LESSON A1–5:
**Immune System Structures**

<table>
<thead>
<tr>
<th>Instructional Time</th>
<th>4 days</th>
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<tbody>
<tr>
<td>Laboratory Time</td>
<td>2 days</td>
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<tr>
<td><strong>NGSS Performance Expectations</strong></td>
<td>HS-LS1-2</td>
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</tbody>
</table>
| **Common Core State Standards** | CCSS.ELA.Literacy.L.11-12.6  
CCSS.ELA-Literacy.RST.11-12.2 |
| **National AFNR Standards** | AS.06.02.03.a  
AS.06.02.03.b |
| **Essential Question** | How is structure related to the function of the immune system? |
| **Student Learning Objectives** | At the conclusion of this lesson, students will be able to:  
1. Discuss and explain the major components of the immune system.  
2. Compare and contrast the types of immunity. |

**ENGAGING Activities: Teacher** *(Opening activity or interest approach—access prior learning / stimulate interest / generate questions)*

1. Have students answer the questions in the “Pathogens or Animals: Which Are More Powerful?” activity, and discuss their answers with the class.

## ANSWER KEY for “Pathogens or Animals: Which Are More Powerful?”

1. **What is a pathogen?**  
   A pathogen is any organism that causes disease.

2. **Provide one example of a pathogen and its impact on an animal.**  
   Many examples and impacts will be shared. Some common pathogens:  
   - Foot and mouth disease (ruminants and swine)  
   - Avian flu (poultry)  
   - Rhinitis (swine and equine)  
   - Ringworm (most mammals)  
   - Parvo (dogs and cats)

3. **How does an animal fight the pathogen?**  
   - Pathogens are fought through innate, adaptive, active, or passive immunities. The students should explain the process, depending on which treatment is chosen.
• Immunizations are the best way for us to help the animal fight pathogens. Multiple diseases have vaccines available, such as parvo, BVD, tetanus, and pneumonia. Specific immunizations and treatments will vary by the chosen pathogen.

EXPLORING Activities: Teacher

(Lesson description; materials needed / probing or clarifying questions; students think, plan, investigate, and then organize collected information; rubrics)

1 Ask the students to come up with questions about the structures of the immune system. These should be questions that they think must be answered for success in learning the material. Make the list visible to the class. With the students’ help, group similar questions, and prioritize the questions in terms of which need answered first. Keep this list readily available, and refer to it as the lesson proceeds.

2 Assign the reading of the corresponding E-unit.

3 Have the students design a lab to expand their understanding of immune system structures. Suggested research topics include:
  • Zoonotic diseases (transmitted from animal to human)
  • Differences in the health mechanisms of wild animals
  • The immune system—attacking its host

4 Conduct the lab activity, “Investigating How Animals Fight Diseases.”

TEACHER NOTES for “Investigating How Animals Fight Diseases”

Helpful Hints:
  • Offer reputable websites as sources and references for the students, such as:
    – Biology Online: https://www.biology-online.org
  • Take time to illustrate how to cite sources and references by using your school’s preferred writing style (APA, MLA, CMOS, etc.).
  • Emphasize that a topic can be researched without a hypothesis. In this case, students can find existing information and report their findings.

Anticipated Findings:
Pathogens and reports will vary among chosen subjects. This lab will give students a good handle on writing a report, and it should increase their critical-thinking and problem-solving skills.

Ideas for Additional Experiments:
  • With more advanced classes, show prepared slides of various pathogens for study under a microscope. The students can compare and contrast the various pathogens in terms of the...
pathogen’s composition, as well as its impact on an animal’s immune system. Have them draw their own conclusions of which pathogens are most dangerous.

- Students can select a specific type of animal. They can prepare a chart of common pathogens that affect its immune system. Have them draw their own conclusions of which pathogens are most dangerous to this animal.

Assess the completed lab reports using the “Investigative Report Scoring Rubric” provided, or modify the scoring rubric for your situation. An oral report on this material will be assigned in the next section.
# Investigative Report Scoring Rubric

<table>
<thead>
<tr>
<th>Possible Points</th>
<th>Sections</th>
<th>Section Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Title:</td>
<td>✓ The title is concise and appropriate.</td>
</tr>
<tr>
<td>10</td>
<td>Introduction:</td>
<td>✓ An introduction is provided that introduces the pathogen and discusses the importance of this pathogen and how it may impact the animal’s health.</td>
</tr>
<tr>
<td>20</td>
<td>Pathogen Causing Disease:</td>
<td>✓ Explanation and description of the pathogen is logical.</td>
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<tr>
<td>25</td>
<td>Immune System of the Animal:</td>
<td>✓ Explanation of how the animal’s immune system fights the disease is provided.</td>
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<tr>
<td>15</td>
<td>Treatment Options:</td>
<td>✓ An explanation is provided of how the pathogen is eliminated from the animal; animal welfare, etc.</td>
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<tr>
<td>10</td>
<td>Conclusion/Remarks:</td>
<td>✓ Suggestions are provided that would implement the research findings and/or further the research on the topic.</td>
</tr>
<tr>
<td>5</td>
<td>References:</td>
<td>✓ Citations and references adhere to the proper format.</td>
</tr>
</tbody>
</table>
| 10              | Presentation:  | ✓ Spelling and grammar are correct.  
|                 |          | ✓ The overall appearance is attractive.  
|                 |          | ✓ The report is clear and concise.  
|                 |          | ✓ The report reflects thoughtful scientific inquiry. |

## Total Score

<table>
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<tr>
<th></th>
<th>F</th>
<th>D</th>
<th>C</th>
<th>B</th>
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Key Terms Defined:

**active immunity**: the creation of antibodies in response to an exposure to an antigen

**adaptive immunity**: a body’s defense mechanisms for fighting unknown antigens

**antibody**: a defensive protein produced to attack specific antigens

**antigen**: a toxin or foreign invader that corrupts cells and causes illness

**B lymphocyte (B-cell)**: a non-thymus leukocyte that is responsible for producing antibodies

**dendritic cell**: a specialized cell that presents antigen information to the other cells and regulates T-cell and B-cell growth and behavior

**edema**: a swollen-tissue condition, caused from an accumulation of interstitial fluid

**eosinophil**: a leukocyte that responds to allergic reactions and attacks parasites (such as worms) by releasing toxins

**immune system**: the set of organs and processes that provide protection from infections, toxins, and foreign bodies

**immunization**: the act of providing an immunity to specific antigens, artificially

**immunological memory**: the cellular ability to recall previous antigen encounters

**inflammatory response (inflammation)**: a series of physiologic processes in response to injuries by antigens or trauma

**innate immunity**: a natural, biological aversion or barrier to certain antigens

**interstitial fluid**: the fluid found outside tissue cells and blood vessels

**lymph**: a colorless fluid (containing white blood cells) that washes tissue

**lymph nodes**: extremely small, encapsulated structures that filter lymph from tissue and dwell along the path of lymphatic vessels

**lymphatic capillary**: an extremely small lymphatic vessel located in the spaces between cells

**lymphatic system**: a group of organs, vessels, and nodes that provide lymph and fluid balance to the bloodstream

**lymphatic vessels**: thin-walled tubes (structured like blood vessels) that transport lymph

**lymphocyte**: a small white blood cell that assists in removing toxins, foreign materials, and pathogens from lymph

**lysozyme**: an enzyme prevalent in saliva, tears, sweat glands, duct milk, and mucus that attacks the cell walls of bacteria

**macrophage**: a phagocyte within body tissue

**neutrophil**: a phagocyte that attaches to the walls of the blood vessel

**passive immunity**: the presence of antibodies without exposure to an antigen

**phagocyte**: a leukocyte that can engulf and digest viruses and bacteria
primary lymphoid organ: an organ in which lymphocytes develop and mature
red bone marrow: a red substance consisting of connective tissue, blood vessels, and the origin cells that make erythrocytes and lymphocytes
secondary lymphoid organ: an organ in which lymphocytes are activated by antigens
spleen: the largest lymphatic organ which is located in the abdomen and is responsible for filtering blood
T lymphocyte (T-cell): a leukocyte processed in the thymus that finds foreign invaders, viruses, and pathogens
thymus: a gland of the thoracic area that produces T-cells
vaccine: an artificially-produced, antigen-based substance designed for the body’s production of antibodies and immunity to a disease

2 Have the students deliver an oral report to the class on the results of their investigative work. Encourage the use of multimedia.

3 Return to the list of questions the students created at the beginning of the lesson. Be sure all have been answered satisfactorily.

4 Assign the “Importance of Immunizations” activity.

**ANSWER KEY for “Importance of Immunizations”**

1. Bordetella in dogs  Immunization
2. Feline leukemia  Immunization
3. Rabies in cats  Immunization
4. Worms in horses  Anthelmintics and antibiotics
5. Respiratory disease in calves  Immunization
6. Fly control in cattle  Backrubbers, dust bags, insecticides, sprays, pour-ons (for skin and hair), oral larvicides, parasitic wasps, and mineral licks with insect-growth regulators
7. Thrush in horses  Betadine©, iodine solution, antibacterials, antibiotics, frog trimming, and dry environments
8. Distemper in dogs  Immunization

**ELABORATING Activities: Teacher**

(Applications and extensions; give students the opportunity to expand and solidify their understanding of the concept and/or apply it to real-world situations)

1. Assign the reading of a related Agricultural Career Profile ([http://www.mycaert.com/career-profiles](http://www.mycaert.com/career-profiles)).

2. Assign the “Types of Immunity” activity.
### ANSWER KEY for “Types of Immunity” Activity

<table>
<thead>
<tr>
<th>IMMUNITY TYPE</th>
<th>DEFINITION</th>
<th>CHARACTERISTIC</th>
</tr>
</thead>
</table>
| Innate Immunity     | A natural, biological aversion or barrier to certain antigens | Lymphatic System: Cleanses tissue, removes dead cells  
                      |                                                      | Physical Barriers: Skin, mucous membranes (lysozyme, stomach acidity) |
| Adaptive Immunity   | A body’s defense mechanisms for fighting unknown antigens | Antibodies: Produced in reaction to antigen  
                      |                                                      | Lymphocytes: B-cells and T-cells, phagocytes, dendritic cells, etc. fight antigens  
                      |                                                      | Memory: Cells remember new antigens for future battle |
| Passive Immunity    | The presence of antibodies without exposure to an antigen | Innate: Passed from mother to child  
                      |                                                      | Artificial: Antibiotics and immunity boosters |
| Active Immunity     | The creation of antibodies in response to an exposure to an antigen | Adaptive: Natural response  
                      |                                                      | Artificial: Immunization and vaccination |

### EVALUATING Activities: Teacher

(Summative assessment: scoring tools)

1. Assign the “Checking Your Knowledge” questions from the related E-unit, and grade the answers.

### ANSWER KEY for “Checking Your Knowledge”

**Part One: Matching**

1. h  
2. e  
3. c  
4. b  
5. a  
6. d  
7. g  
8. f

**Part Two: Completion**

1. T lymphocytes or T-cells  
2. Lysozyme  
3. phagocyte  
4. Interstitial fluid  
5. Lymphatic vessels  
6. edema  
7. dendritic cell  
8. thymus

**Part Three: True/False**

1. F  
2. T  
3. T  
4. F  
5. T  
6. T  
7. F  
8. F  
9. T  
10. F
Administer a written test to determine mastery of terms and concepts. A sample test has been provided in the “Assessing What You’ve Learned” activity.

ANSWER KEY for “Assessing What You’ve Learned”

1. **How does the interstitial fluid benefit the animal’s body?**
   
   Interstitial fluid is the fluid found outside tissue cells and blood vessels. It provides a significant proportion of liquid within the body. It contains lymph.

2. **How do B-cells and T-cells differ?**
   
   A B lymphocyte (B-cell) is a non-thymus leukocyte that is responsible for producing antibodies. It remains in the red bone marrow until maturity, and then it is released into the bloodstream. In contrast, a T lymphocyte (T-cell) is a leukocyte processed in the thymus that finds foreign invaders, viruses, and pathogens. T-cells send a signal to the B-cell to produce antibodies and can aid in the attack of the infected cells.

3. **What is the role of an antibody?**
   
   An antibody is a defensive protein produced to attack specific antigens. Antibodies attach to the antigens and try to eliminate them.

4. **What is the purpose of the lymphatic system?**
   
   The lymphatic system is a group of organs, vessels, and nodes that provide lymph and fluid balance to the bloodstream. This system includes lymphatic vessels, lymph nodes, and associated lymphoid organs (such as the spleen or thymus) that return excess interstitial fluid to the bloodstream and defend the body against disease. Interstitial fluid is the fluid found outside tissue cells and blood vessels. It provides a significant proportion of liquid within the body, and it contains lymph, the part of this system that washes tissue. The lymphatic system also allows the small intestine to absorb fats (called lipoproteins) and transport them to the bloodstream. Finally, it provides sites for the production and distribution of the lymphocytes.

5. **What is an inflammatory response?**
   
   An inflammatory response (inflammation) is a series physiologic processes in response to injuries by antigens or trauma. The inflamed area may be red, hot to the touch, swollen, and painful. This response can also be internal, causing an overreaction of chemicals that repair or protect tissue. This large, cellular response can damage the tissue it is trying to repair.
Pathogens or Animals: Which Are More Powerful?

Instructions: Use the Internet to complete the following.

1. What is a pathogen?

2. Provide one example of a pathogen and its impact on an animal.

3. How does an animal fight the pathogen?
Investigating How Animals Fight Diseases

PURPOSE

Investigate how an animal’s immune system is impacted by a selected animal disease.

OBJECTIVE

Prepare a report on how a specific pathogen affects an animal’s immune system.

MATERIALS

- device with Internet access
- E-unit and/or other research materials
- printer
- word processing and media applications

PROCEDURE

2. Select one of the animal diseases listed on the website.
3. Read about the disease. Find additional sources that focus on this disease.
4. Prepare an investigative report that includes the following:
   a. Title
   b. Introduction (introducing the topic)
   c. The pathogen and its infection properties
   d. An animal’s immune defenses—how it fights the disease
   e. Treatment options (vaccines, antibiotics, etc.)
   f. Conclusion (a summary of facts and interpretations)
   g. References (websites, literature, or reference books)
5. The report should be typed, double-spaced, and include the appropriate use of citations. Grammar, spelling, and neatness will be assessed.
6. Your investigative report should be at least three to five pages in length, not including the reference or title pages.
7. Turn in your report to the instructor. Be prepared to give an oral presentation with media.
Importance of Immunizations

*Instructions:* Using the Internet, find out which of the following health issues are treatable with immunization. Make a notation next to the affliction. If not, research them online, and list other treatment options.

1. Bordetella in dogs

2. Feline leukemia

3. Rabies in cats

4. Worms in a horse

5. Respiratory disease in calves

6. Fly control in cattle

7. Thrush in horses

8. Distemper in dogs
**Types of Immunity**

*Instructions*: Complete the table below with the correct definitions of each type of immunity. Then, provide one characteristic of each type.

<table>
<thead>
<tr>
<th>IMMUNITY TYPE</th>
<th>DEFINITION</th>
<th>CHARACTERISTIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innate Immunity</td>
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<tr>
<td>Adaptive Immunity</td>
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<tr>
<td>Passive Immunity</td>
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<tr>
<td>Active Immunity</td>
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</tbody>
</table>
Assessing What You’ve Learned

ESSAY QUESTIONS

Instructions: Provide a detailed explanation of the processes or principles in answering the following questions.

1. How does the interstitial fluid benefit the animal’s body?
2. How do B-cells and T-cells differ?
3. What is the role of an antibody?
4. What is the purpose of the lymphatic system?
5. What is an inflammatory response?