

Wk16 Lab report: Immune system modeling

Your goal: Model an antigen-antibody response to show how adaptive immunity targets pathogens.

One product: Comparison diagram of primary vs. secondary immune response with labeled antibody levels and timescales, plus model notes describing how matched antibodies neutralize the pathogen.

Question: How can matching and memory change a response, and what can a paper model actually show?

Start the work

Barriers, innate responses and adaptive responses cooperate; specific memory can improve later responses without guaranteeing protection.

1. Review antigen recognition and antibody binding.
2. Build a model pairing antibody shapes to antigen shapes.
3. Simulate a first exposure and a memory response using the supplied original rules.
4. Show how matched antibodies can neutralize the model pathogen by blocking its entry site.
5. Record how the response speeds up in this model, without treating model ticks as biological time.

If access is unavailable, save the complete report and tell the teacher. Try the assigned upload when access works, then check that Schoology shows Submitted.

Words you will use

immune system

Cells, tissues and organs that work together in defense.

innate immunity

Defense through barriers and cells that recognize shared patterns of microbes or damage.

adaptive immunity

Defense using B and T cells with specific receptors; it can form memory.

pathogen

An agent, such as a virus, that can cause disease.

antigen

A molecular structure recognized by an antibody or a lymphocyte receptor.

epitope

The particular part of an antigen contacted by a receptor or antibody.

antibody

A protein released by plasma cells that binds a matching target.

protein

A molecule built from amino acids that can perform cell tasks.

binding site

The region of a molecule that contacts its target.

complementary

Having features that fit together; here, a binding site and its target.

specificity

Preference for particular targets rather than equal binding to everything.

binding

Molecules attaching through interactions between their surfaces.

cross-reactivity

Recognition of more than one related target by the same antibody or receptor.

B cell

A white blood cell that can develop into an antibody-secreting plasma cell.

plasma cell

An activated B-cell descendant that releases antibodies.

memory B cell

A long-lived B cell that can help mount a later response to its target.

helper T cell

A T cell that supplies signals supporting other immune cells.

activation

A change that starts a cell response after the needed signals.

expansion

An increase in the number of responding cells through cell division.

primary response

The response to a first encounter with a particular target.

secondary response

A response to a later encounter with a target already encountered.

exposure

An encounter with a target; it does not itself establish illness.

immune memory

Changes after an encounter that can improve a later response.

neutralization

Blocking a pathogen or toxin from causing its usual harmful action, such as entry into a cell.

receptor

A molecule that binds a target and can help start a cell process.

entry site

In this model, the viral feature needed to attach to the host cell.

host cell

A cell a virus could enter and use to make more virus.

vaccine

A preparation that presents an antigen or instructions for making one to prepare an immune response.

mutation

A change in genetic material; its effects can vary.

antigenic drift

Changes in flu viruses that can alter how immune defenses recognize their surface antigens.

model

A simplified representation built to explore selected relationships.

model tick

One step in this paper sequence; it has no conversion to hours or days.

antibody token

One mark representing an arbitrary model antibody-level unit, not one measured molecule.

antibody level

The amount of antibody represented or measured; the units must be stated.

timescale

The time units and span used to describe a process.

hypothesis

A prediction with a reason that can be checked against a stated model or evidence.

assumption

A rule or condition taken as given within a model.

legend

A key explaining marks, line types and labels.

variable

A feature that can differ or change.

limit

A conclusion that the supplied evidence cannot support.

simulation

A run of stated rules to represent a process.

lymph

Fluid carried from tissues through lymphatic vessels.

CER

Claim, evidence and reasoning: an answer, its support and the connection between them.

H1: what you will build

Build an original paper model, then save a comparison diagram and model notes together. You will show matching, a first response, a repeat response and one way binding can block viral entry.

Use plain paper and a pencil. You may sketch every part without cutting or sharing materials. If using teacher-provided cards, confirm their rules first. Keep those records separate if their rules differ.

No microbes, body samples, medicines or health histories are needed. Use classroom directions for any shared tools. Do not conduct an infection test. A paper run cannot establish a person's immune status.

E1: recognition and cell roles

MedlinePlus describes the immune system as a network of cells, tissues and organs working in defense. Use that fact to explain why antibody matching represents only part of the whole response.

A pathogen may carry many antigens. An antibody contacts an epitope, a particular part of an antigen. Its binding site has features that fit that target. Shape helps explain this fit, but real binding also depends on chemical interactions.

A B cell already has receptors before it meets a target. The encounter selects cells able to respond. With the needed signals, activated cells expand. Some become plasma cells that release antibodies; some become memory cells. Helper T cells support many of these responses.

An antibody is a protein, not a cell that learns or remembers. Memory B cells can later help produce plasma cells and antibodies. A single antibody can sometimes bind related targets. Specificity does not mean one rigid key fits only one possible germ.

E2: binding, blocking and memory

Binding and neutralization are different claims. An antibody can block infection if it prevents a virus from using a needed entry feature. Binding elsewhere may not block entry. Other immune actions can still matter.

A first response often needs days while selected cells expand and become plasma cells. A repeat encounter with the same target can lead to a quicker, stronger response. Innate and adaptive defenses can overlap.

Vaccination can prepare an immune response before a later encounter with a pathogen. Protection varies with the vaccine, the target and the person. Memory does not promise lifelong protection, zero illness or a milder second infection in every case.

Our model shortens the cell steps and uses a simple fit rule. Its clock and antibody levels are invented teaching units. They are not measurements, a clinical cutoff or a forecast of recovery.

S1: complete original shape model

On paper, draw a large circle labeled virus A. Add one triangle tab on its edge and label that tab entry epitope A. Draw virus B as another circle with a square tab labeled epitope B.

Draw a Y labeled antibody A. At both tips, draw a triangle-shaped hollow and label each binding site. Draw a second Y with square hollows and label it antibody B. Size each hollow to fit its matching tab in your sketch.

Draw a host-cell edge with a triangle hollow labeled entry receptor. In this model, A's triangle can reach that receptor when uncovered. Draw antibody A covering the triangle: the covered tab cannot contact the receptor. Label this blocking step neutralization in this model.

Use this exact model rule: triangle fits triangle hollow; square fits square hollow; triangle and square do not fit. Test and record antibody A with A, antibody A with B, and antibody B with B. The shape names work without color.

Before testing, predict the three matches and give a reason. Sketch a matched pair and a mismatch. These are checks of the stated paper rule, not molecular binding experiments. Do not generalize this binary rule to every real antibody.

Draw one box labeled responding B cell, one labeled plasma cells and one labeled memory B cells. Connect responding B cell to plasma cells and memory B cells. Connect plasma cells to antibodies. These arrows show cell development or release, not fluid flow.

D1: two complete model runs

The table below is a rule sheet, not observed data. In each run, introduce virus A at model tick 0. Keep the same paper shapes, fit rule and tick spacing. The repeat run starts with memory B cells already marked.

Draw a seven-row record with columns model tick, first-run antibody tokens, repeat-run antibody tokens and process note. Copy ticks 0, 1, 2, 3, 4, 5 and 6. Leave your result columns blank until you run each sequence.

Rule table for ticks 0 through 6: first-run antibody-token levels are 0, 0, 0, 1, 2, 3 and 2. Repeat-run levels are 0, 2, 4, 6, 5, 4 and 3. Each number is the total at that tick, not an amount to add.

First run: mark the B-cell box at tick 0. At ticks 1 and 2, mark activation and expansion. At tick 3, mark plasma cells and place one antibody token. Follow the remaining totals, then mark memory B cells available for a later encounter.

Before the repeat run, reset the displayed antibody tokens to zero but keep the memory-cell mark. This deliberate simplification isolates the memory route; real antibodies can remain between encounters. The gap between encounters is unspecified.

Repeat run: reintroduce A at tick 0. At tick 1, mark memory-cell activation leading to plasma cells and set two tokens. Follow the remaining totals. Explain that these prescribed rules, not an experiment, create the faster model response.

At each tick, draw or move tally marks until they equal the stated total. Record the total and process note. If you lose your place, redo that tick and label the correction. Do not label a copied rule table as a performed run.

Compare the first tick with at least one token in each run. Subtract the repeat-run tick from the first-run tick. Report the difference in model ticks. This threshold is only a comparison rule, not an immune-protection threshold.

For the comparison diagram, use two panels with the same scales. Label each horizontal axis time since exposure, model ticks 0–6. Label each vertical axis antibody level, model tokens 0–6. Plot all seven points in each panel and join neighboring points to show the model sequence.

Label first exposure and repeat exposure at their own tick 0. Add a legend and mark where the memory route is used. Write: no conversion to real days or antibody concentration. A line between points guides the eye; it does not supply new measurements.

E3: a real example and the extension

CDC explains that flu viruses change over time. Some changes affect surface antigens. Antibodies against one virus can still recognize a related virus with similar antigen features. Larger or strategically placed changes can reduce recognition and protection.

Flu vaccine composition is reviewed each year and updated as needed. A mutation does not automatically make every antibody useless or force a new vaccine. The effect depends on what changed and how immune responses recognize it.

For an optional extension, imagine that A's entry epitope changes. Case X says existing antibodies still bind it. Case Y says binding is reduced. Explain why these cases allow different predictions. Name the binding and neutralization evidence needed before claiming lost protection.

C1: self-check and independent exchange

Check: both A and B are present under S1's exact rules. You have antibody A. Predict which target binds. Explain which model entry step could be blocked, why this helps explain vaccine specificity, and one limit of the analogy.

After your answer, check the reasoning against S1's exact fit rule: compare antibody A's shape with each target, then name the entry tab a fitting antibody would cover. Vaccines can prepare target-related responses. The model does not prove universal one-target binding or guaranteed protection.

Work with a partner only if available. Ask: Does binding prove neutralization? Record the actual answer, then improve your explanation. Working alone, critique this supplied claim: Every antibody that binds also blocks infection. Use E2 and revise the claim.

If you need a smaller start, sketch antibody A and epitope A. Label their fit, then label a B cell and a plasma cell. Return to both full runs, all diagram points and the neutralization note. The smaller start does not replace the product.

P1: your assigned work and next lesson

For May 3, prepare Innate and adaptive immunity for 25 minutes in Class Records. Define antigen, antibody and B cell, and explain one limit of the shape analogy. Keep this preparation separate from the 80-minute lesson.

Ask your teacher which Lesson 3.2 simulation or Activity 3.2.2 modeling task is assigned. Confirm the activity, partner directions and required materials. Complete that assigned work when available; today's original model does not complete it automatically.

Activity 3.2.2 Immune Defense includes cell research, comparisons of bacterial and viral responses, teacher-led origami demonstrations and a ten-term concept map. Obtain the assigned video, model tours, template, full build directions and Amazon Travel Journal pages 7–8 before that work.

Keep any assigned 3.2.1 organizer, seven-structure model and journal pages 1–2 on your checklist. Do not mark a prior immunity task done because you read its lesson. Save the requested note or screenshot only after genuine assigned completion.

The May 3–7 checklist includes evidence through 3.2.3 Going Un-Viral and an Immune defense model. It also lists vaccine-data CER, transmission, a plaque assay and eye dissection. Obtain the teacher packet and assigned Khan resources for absent work.

Ask your teacher whether any debate work is assigned this week and which remaining tasks apply. Keep any confirmed debate or later practical work separate; this model performs neither.

Tomorrow, May 4, bring this diagram and your model notes for antibody-data analysis and CER. Obtain the actual assigned data before making claims about it. Do not turn today's model ticks or tokens into actual vaccine results.

Use the original model, official task, preparation, tracker and submission checks to identify a specific next action; describe only work you actually do. Name missing materials or access when needed. Do not invent a partner answer, measured value or upload.

M1: a different worked model

M uses a fictional virus C with a round entry tab and a separate square side tab. A square-hollow antibody binds the side tab. The round entry tab remains exposed. My drawing labels binding present, entry blocking not shown. I cannot infer neutralization from this fit alone.

For a separate short timing example, the first-run totals at ticks 0, 1 and 2 are 0, 0 and 1. The repeat totals are 0, 1 and 2. Both are invented model-token levels, with equal tick spacing.

My first nonzero ticks are 2 and 1, so the difference is $2 - 1 = 1$ model tick. I draw two panels with horizontal ticks 0–2 and vertical tokens 0–2. I plot each supplied pair and label the units.

My note says the repeat model crosses the one-token rule earlier. Its rules represent faster output after memory-cell activation. They do not show a one-day change or prove clinical protection. Use D1's different seven-tick inputs for your own work.

Try the decision

You completed the original D1 paper rules. Which report statement stays within the model evidence?

- The repeat model reaches a nonzero token level earlier under its memory rule; real protection and timing remain unmeasured.

- Binding any antibody neutralizes every pathogen, so the model proves the next infection will be milder.
- Relabeling model ticks as days makes its timing predict the exact biological response.

Explain your choice using the reading. Discuss it or say it to yourself. This practice does not add another submission.

Your 80-minute flow

0–10 minutes	Read E1/E2 and vocabulary as needed; write the two predictions.
10–22 minutes	Build S1, test all three pairs and add the cell-role arrows and MedlinePlus note.
22–42 minutes	Study M1, then run and record all first-exposure ticks. Draw the before/after blocking sketch.
42–58 minutes	Run and record the repeat sequence. Compute first-nonzero timing difference and explain the memory rule.
58–70 minutes	Draw the fourteen-point comparison with labels and limits. Complete C1 and the partner or solo critique.
70–80 minutes	Revise predictions, assemble the report, identify your next action and submit if access allows. Extension only after core work.

Your response record

Use these labels on paper or in your document. The space below also works when this page is printed.

Predict before running

Write two predictions: how fit affects recognition, and what remains after a first response. Then predict S1's three pair results before testing.

Use E1 and S1. Treat the key analogy as a starting model, not an absolute rule.

Use this space or the same labeled section in your existing document. Add paper when your table, graph or drawing needs more room.

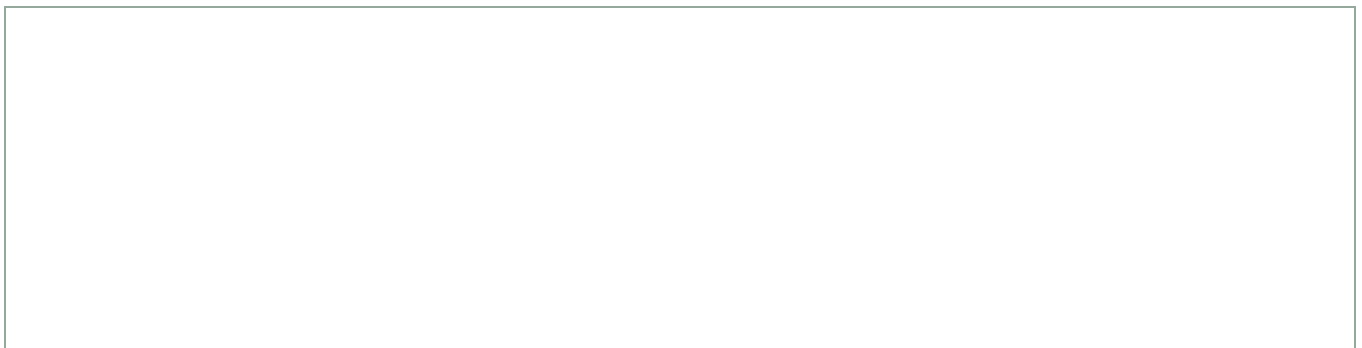


Build and test the paper model

Make the S1 shapes and labeled cell boxes. Record all three matches, the matching pair and the mismatch. Include one MedlinePlus E1 fact about the whole immune system.

Pencil sketches are enough. Label binding sites and epitopes; show B-cell development and antibody release with arrows.

Use this space or the same labeled section in your existing document. Add paper when your table, graph or drawing needs more room.



Run first exposure

Run all seven first-exposure ticks in D1. Record totals, process notes and any corrections.

Use total tokens, not cumulative addition. Separate your prediction, actual paper action and interpretation.

Use this space or the same labeled section in your existing document. Add paper when your table, graph or drawing needs more room.

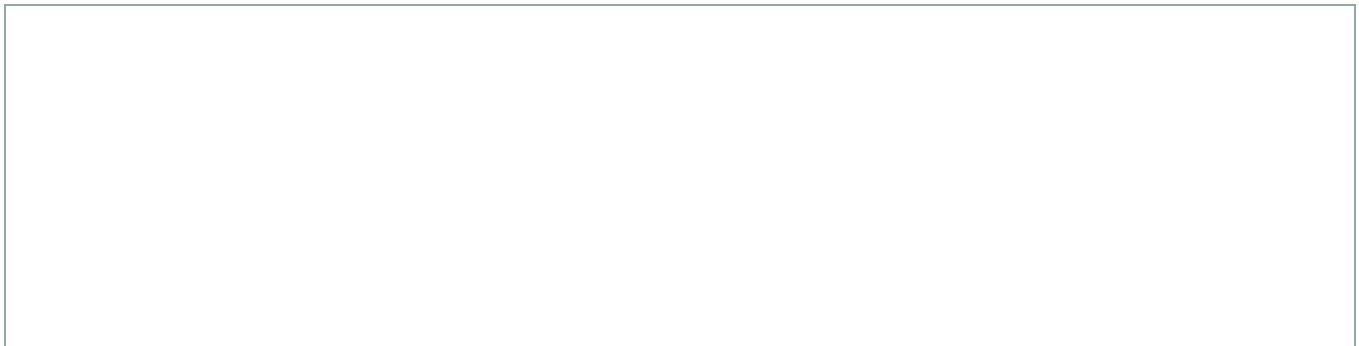


Run repeat exposure

Reset as directed, retain the memory-cell mark and run all seven repeat-exposure ticks. Compare first nonzero ticks and calculate the difference.

Keep model ticks as the unit. Explain the reset assumption and why these rules cannot measure real response speed.

Use this space or the same labeled section in your existing document. Add paper when your table, graph or drawing needs more room.



Show neutralization

Draw A before and after antibody A covers its entry tab. Explain why the covered tab cannot reach the modeled host receptor. Contrast this with M1.

Binding is shown by fit; blocking is shown by loss of receptor contact. Do not claim all bound antibodies neutralize.

Use this space or the same labeled section in your existing document. Add paper when your table, graph or drawing needs more room.

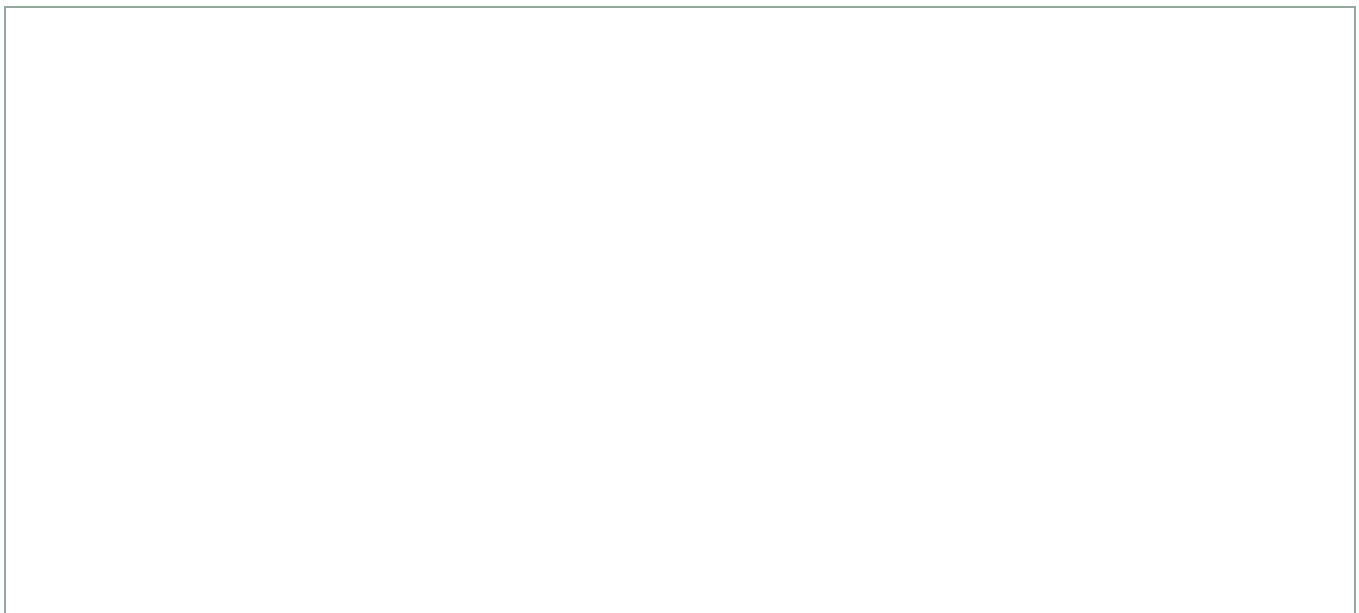


Make the comparison diagram

Plot both D1 runs in two panels using identical 0–6 scales. Include all fourteen points, level/time labels, legend, exposure marks and the memory-route note.

Use M1 for the method, not its numbers. Add both the no-real-time conversion limit and the arbitrary-level limit.

Use this space or the same labeled section in your existing document. Add paper when your table, graph or drawing needs more room.



Explain, check and revise

Answer every part of C1's A/B check. Complete the real partner exchange or supplied solo critique. Revisit the two opening predictions with evidence.

Explain vaccine preparation using E2. The one-token comparison does not establish protection.

Use this space or the same labeled section in your existing document. Add paper when your table, graph or drawing needs more room.

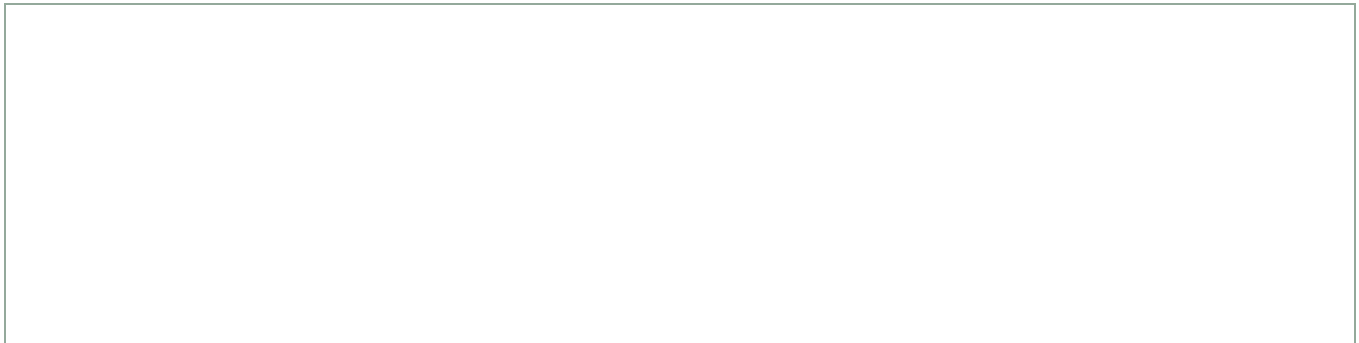


Optional changed-target extension

After core work, compare E3 Cases X and Y. Explain what is known and what must be tested before claiming a vaccine update is needed.

Use the CDC fact about annual review and updates as needed. Do not treat every mutation as loss of all recognition.

Use this space or the same labeled section in your existing document. Add paper when your table, graph or drawing needs more room.



Finish the report and check your next step

Keep diagram, three fit checks, both run records, calculation and neutralization notes in the same lab report. Use P1 to identify what you checked and anything you need; bring the work tomorrow.

If absent, complete the full paper route. Ask for missing official materials or access. After uploading, check that Schoology shows Submitted.

Use this space or the same labeled section in your existing document. Add paper when your table, graph or drawing needs more room.

Check your product

- Model shows specific antibody-antigen matching.
- Notes describe a faster secondary memory response in the supplied model.
- The comparison has both full runs, labeled antibody levels and model timescales, plus the blocking mechanism and its limit.
- Include all model actions in the report and keep evidence from the assigned official work separate.

Keep the limit: These original paper rules model matching, entry blocking and earlier antibody output after memory. Their ticks and tokens cannot predict real days, concentrations, illness, vaccine effectiveness or official completion.

Turn in your work

Submit the comparison diagram and model notes together to Wk16 Lab report: Immune system modeling in your enrolled section. HBS 1292: <https://app.schoology.com/assignment/8544596861/info> . HBS 6792: <https://app.schoology.com/assignment/8544596886/info> . Confirm the live due date and Lab Reports route. Keep required run records and explanations with that report.

If access is unavailable, save the complete report and tell the teacher. Try the assigned upload when access works, then check that Schoology shows Submitted.

[Section 1292: Wk16 Lab report: Immune system modeling](#)

[Section 6792: Wk16 Lab report: Immune system modeling](#)

Carry forward

Specific binding can help block infection, and memory can speed a later response; neither guarantees protection.

Tomorrow, compare antibody records with their units and timing. A larger response alone does not prove that someone cannot become ill. How do timing and units change the interpretation of an antibody comparison?

Sources and resources

[Open today's page](#)

MP · Immune System and Disorders

MedlinePlus, National Library of Medicine

<https://www.medlineplus.gov/immunesystemanddisorders.html>

OS · 21.4 The Adaptive Immune Response: B-lymphocytes and Antibodies

OpenStax, Rice University

<https://openstax.org/books/anatomy-and-physiology-2e/pages/21-4-the-adaptive-immune-response-b-lymphocytes-and-antibodies>

JAN · The Humoral Immune Response

Janeway and colleagues, Immunobiology, 5th edition, 2001; NCBI Bookshelf

<https://www.ncbi.nlm.nih.gov/books/NBK10752/>

CDC · Chapter 1: Principles of Vaccination

Centers for Disease Control and Prevention

<https://www.cdc.gov/pinkbook/hcp/table-of-contents/chapter-1-principles-of-vaccination.html>

CDC-FLU · How Flu Viruses Can Change: "Drift" and "Shift"

Centers for Disease Control and Prevention

<https://www.cdc.gov/flu/php/viruses/change.html>