

Medical Interventions (Genetics of Disease)

Period 3-4 · Mr. Mendoza · Student agenda



Hello, Period 3-4. This week the mystery infection case closes and a new question opens: once you know the germ, how do you fight it without breeding a tougher one? Every term below is explained in this packet. Story sections S1 to S5 walk through each day; Reference pages R1 to R20 explain one tool or word each; A1 and A2 are labeled maps.

Unit 1 Test: Friday, October 2. 40 minutes, on paper, at the start of class. It covers what we have done in class so far this unit.

1. Read the **Study Guide**: https://mendozabiomed.org/exams/study-guides/MI_unit-1-how-to-fight-infection_endunit_guide.pdf
2. Take the **Practice Test**, then check the key at the end: https://mendozabiomed.org/exams/study-guides/MI_unit-1-how-to-fight-infection_practice-test.pdf
3. Use the 6 Rs: Record and Reduce your notes early in the week, Review and Recite the night before, then Reflect and Revise after the practice test. Both links are also in the “Unit 1 Test prep” box under Sources on every day page.

Monday, Sept 28 · ELISA lab report

Build one report from your Sept 23 ELISA record: plate photo, color data table, a Claim checked against your two controls (R4), a Reasoning paragraph, a sensitivity and specificity paragraph (R6), and one limitation. The day page warns: “a report that does not state its cutoff has hidden the most important decision in the whole assay” (R5). Read S1 first; name your wells with A2.

myPLTW: Medical Interventions > Lesson 1.1 The Mystery Infection > Activity 1.1.6 Final Diagnosis: use your ELISA results to complete the diagnosis.

Turn in: the full report to Schoology, Wk6 Lab report: ELISA lab report submission, by the end of class.

Day page: <https://mendozabiomed.org/learn/pltw-gend/day/2026-09-28>

Tuesday, Sept 29 · Bioethics debate: antibiotic stewardship

Write a CER (R9) that answers the day page's question, “how strictly should antibiotic use be controlled?”, with evidence about resistance (R7) and patient need, a partner's counterpoint, and a rebuttal. Key fact: “The drug itself does not weaken; the bacterial population changes.” Stewardship: R8. Story: S2.

myPLTW: Medical Interventions > Lesson 1.2 Antibiotic Treatment > Activity 1.2.1 Antibiotic Therapy, then review the CER rubric.

Turn in: one PDF to Wk6 CER: Bioethics debate, antibiotic stewardship, by the end of class.

Day page: <https://mendozabiomed.org/learn/pltw-gend/day/2026-09-29>

Wednesday, Sept 30 · Disk diffusion and MIC lab

Goggles and gloves on; wait for my safety approval. Label the base of your agar plate (R10, A1), place antibiotic disks (R12) on the bacterial lawn (R11) with aseptic technique (R17), tape the lid, incubate lid down (R16). Then the setup record: plate map, labels, a prediction for each disk. Set up Thursday's empty table: one row per disk, zone (mm), zone rank. Day page, Part 2, steps 1 to 3. Story: S3.

myPLTW: Medical Interventions > Lesson 1.2 Antibiotic Treatment > Activity 1.2.1 Antibiotic Therapy: apply how antibiotics act to the case patient.

Turn in: the setup record as one PDF to Wk6 Data table: Disk diffusion and MIC lab, by the end of class.

Day page: <https://mendozabiomed.org/learn/pltw-gend/day/2026-09-30>

Thursday, Oct 1 · John Carroll debate 2: Should we ban antibiotic use in livestock?

Bring your preparation assignment. John Carroll leads minutes 0 to 40; sides are assigned in the room (R20, R9). Minutes 40 to 50: read your plate through the taped lid, measure each zone of inhibition edge to edge through the disk's center in whole millimeters (R13), read each drug against its own row of the zone-size chart (R15), finish the table (day page, Part 2, the step after the debate). Story: S4.

myPLTW: Second half of the block: continue Medical Interventions > Lesson 1.2 Antibiotic Treatment > Activity 1.2.1 Antibiotic Therapy.

Turn in: one PDF to Wk6 CER: JCU bioethics 2, should we prohibit antibiotic use in livestock?, by the end of class: your debate worksheet with the finished zone table as its last page. That is your only upload today.

Day page: <https://mendozabiomed.org/learn/pltw-gend/day/2026-10-01>

Friday, Oct 2 · Unit 1 Test, then aseptic technique pre-lab

UNIT 1 TEST, minutes 0 to 40, on paper. Bring a pencil. Then the pre-lab (R17, R18, R19): list contamination routes, write the aseptic steps in order, practice the motions dry (no flame today), explain why a plate stays open as briefly as possible, write safety rules for cultures and waste, and sketch your clean versus contaminated prediction (day page, Part 2, steps 1 to 6). Story: S5.

myPLTW: Medical Interventions > Lesson 1.2 Antibiotic Treatment > Project 1.2.3 Attack of the Superbugs: review the culturing protocol.

Turn in: the pre-lab as one PDF to Wk6 Pre-lab: Aseptic technique by 11:59 PM Friday, and bring it to the culturing lab on Monday, October 5.

Day page: <https://mendozabiomed.org/learn/pltw-gend/day/2026-10-02>

Each day's page is [mendozabiomed.org/learn/pltw-gend/day/\(date\)](https://mendozabiomed.org/learn/pltw-gend/day/(date)), for example mendozabiomed.org/learn/pltw-gend/day/2026-09-28. Absent? Open that day's page, follow its absent steps, and see me when you return. Questions? Ask me in class or message me in Schoology. **Go**

Hornets! Mr. Mendoza

Five days, one question: how do we fight an infection without losing the weapon?

How to read this: each story follows one class day in order. The patients in our PLTW case are fictional; the science is real. A term in bold with a code like (R5) has its own Reference page. Each story ends where your own thinking starts, then points you to the exact task on the day page.

STORY S1 · MONDAY, SEPTEMBER 28 · ELISA LAB REPORT

The Well That Had to Stay Clear

Three weeks ago a folder landed on your desk: case histories from an outbreak, seven people whose stories overlapped in ways nobody had untangled. You sorted what a clinician measured from what a patient reported. You drew a contact map and refused to draw arrows you could not prove. Then you went hunting for the culprit in its DNA, lining up a sequence against known organisms with BLAST, and learned that even a strong match is a comparison that still needs other evidence.

Then the question changed. Knowing what the germ is was one problem. Proving that a particular person's sample carried it was another. For that, the class turned to a test built from the body's own weapons: antibodies.

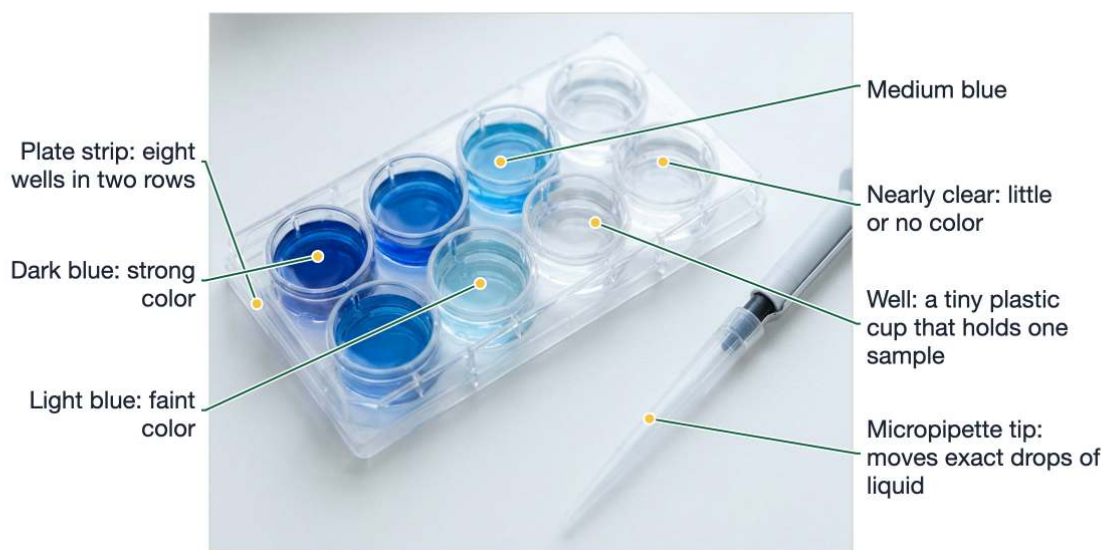


Figure S1. What an ELISA strip can look like after the substrate goes in (an illustration, not your plate). Color appears only where the full chain survived the washes.

Here is how the test works, in the order it happens. First, a sample goes into a tiny plastic cup called a **well (R3)**, and whatever in it can stick to plastic sticks. If the target is there, the target sticks too. That target is the **antigen (R2)**. Next comes the primary antibody, a Y-shaped protein whose arm tips fit one antigen the way a key fits one lock. If antigen is waiting on the floor of the well, the antibody grabs it and holds on. Then the well is washed, and everything that did not grab anything goes down the drain. After that comes a second antibody that grips the first one, and this one carries a passenger: an enzyme, a protein that speeds up one chemical reaction over and over. Wash again. Last, a clear liquid called the substrate goes in. Wherever the whole chain still stands, from antigen to enzyme, the enzyme turns the clear substrate blue.

That is the whole idea of an **ELISA (R1)**. The goal was to identify whether one particular antigen was present in each sample. The enzyme was the indicator that made an invisible molecule visible as color. No chain, no enzyme. No enzyme, no blue.

But color can lie. If a wash is rushed, loose enzyme-carrying antibody stays behind and makes blue where no antigen ever was. So every run carries two wells whose answers are known before the test starts: the **positive and negative controls (R4)**. The positive control should turn blue; the negative control should stay nearly clear. You read those two before anything else.

Then comes the decision the day page calls out in its trap: color is continuous, and someone has to pick the line where a shade becomes a call. That line is the **cutoff (R5)**. Behind it sit the two rates you met on September 25, **sensitivity and specificity (R6)**, and both need a reference standard, some trusted way to know who truly has the condition.

On September 23 your six-well record came either from a classroom kit your group ran or from the supplied record called Strip 1. Say which in your report. Either way, today's driving question is the one a clinician lives with: which of these wells would you be willing to tell a patient about? That answer is your Claim, and it belongs to you.

NOW OPEN THE PACKET TASK

Now open the Monday day page, Part 2, step 1: "Assemble your plate photo, color data table, and control results." Then follow its clock: Claim by minute 27, Reasoning by 47, the sensitivity and specificity paragraph by 60, one limitation by 70, submitted and confirmed by 80. Use A2 to name your wells. No plate photo because you worked from Strip 1? Ask Mr. Mendoza what goes in that slot before you submit.

What this lesson was trying to teach

A color is evidence only after the controls show the run worked and a stated cutoff turns a shade into a call. The skill is a lab report that carries its own reliability: the controls, the cutoff, what sensitivity and specificity require, and one honest limitation.

PLTW connection. In myPLTW, open Medical Interventions > Lesson 1.1 The Mystery Infection > Activity 1.1.6 Final Diagnosis. The day page asks you to use your ELISA results there to complete the diagnosis. Your report practices the same move: turning test results into a conclusion you can defend, with its limits stated.

If we had the full lab

In a hospital or reference lab, an ELISA runs on a plastic plate with 96 wells, and every step follows a validated kit protocol.



Figure S1b. A clinical ELISA: the 96-well plate goes into a microplate reader after the stop solution has turned developed wells yellow.

1. The wells arrive coated: the antigen, or a capture antibody, is already stuck to the plastic.
2. A blocking buffer (a protein or detergent solution) covers the bare plastic so antibodies cannot stick where they should not. This lowers background color.

3. Patient samples go in beside the kit's calibrators and controls, then incubate.
4. A wash buffer, usually buffered salt water with a little detergent such as 0.05% Tween-20, rinses away everything unbound, often from an automatic plate washer.
5. An enzyme-linked secondary antibody goes in, commonly carrying the enzyme horseradish peroxidase (HRP). Another wash follows.
6. The substrate TMB goes in. Wherever HRP sits, TMB turns blue.
7. A stop solution (sulfuric or phosphoric acid) halts the reaction and turns the blue to yellow.
8. A microplate reader shines light through each well and reports absorbance at 450 nanometers: a number for every well instead of a shade.
9. The kit's decision rule turns each number into a call. A positive screening ELISA is followed by a confirmatory test before anyone is diagnosed.

Time and safety. The classroom Bio-Rad ELISA kit is built so each incubation takes 5 minutes at room temperature; clinical kits set their own validated times. Staff wear gloves and eye protection, and the Bio-Rad manual strongly recommends both for students too.

How it connects. Your record used color words and a 0 to 3 scale scored by eye. A plate reader measures the same blue as a number, which lets a lab set its cutoff at a measured value. That is exactly why the day page's worked example names scoring by eye as its limitation.

A Cough, a Prescription, and a Stranger Down the Street

Picture a small clinic on Cleveland's east side on a cold morning. A teenager sits on the paper-covered exam table, coughing into his elbow. His mom wants him back in school. Somebody in the waiting room says what everybody is thinking: just give him an antibiotic.

Start with what an **antibiotic (R7)** is: a drug that kills bacteria, or stops them from multiplying, by attacking parts only bacteria have, such as the tough mesh of the bacterial cell wall, a molecule called peptidoglycan. A virus is not a cell and has no cell wall, so an antibiotic has nothing to hit.



Figure S2. The decision in the exam room: will an antibiotic help this cough, and who else does the choice affect?

So the first job in that exam room is identification: bacterial or viral? For a sore throat, CDC guidance is blunt. A clinician cannot use the exam alone to tell a viral sore throat from strep throat when there are no clear viral symptoms, so a test decides (the full-lab box shows how).

Now follow what happens when an antibiotic enters a body that carries bacteria, which every body does. First, the drug reaches billions of bacterial cells. Most are susceptible, and they die. A few carry a mutation, or a gene picked up from another bacterium, that protects them. Those survive. Then the survivors multiply into the space the dead ones left. The day page puts it in one line: "The drug itself does not weaken; the bacterial population changes." This is selection, and it happens even when the antibiotic was prescribed for a virus, because the bacteria already living on the patient still feel the drug.

And the survivors do not stay home. Resistant bacteria spread to family, classmates, and strangers. Coordinated effort to use antibiotics only when and how they help, so that they keep working, is called **antibiotic stewardship (R8)**. In 1945, Alexander Fleming, who discovered penicillin, warned in his Nobel lecture that misuse would breed resistant bacteria. Today the CDC estimates that more than 2.8 million antimicrobial-resistant infections happen in the United States each year, and that more than 35,000 people die as a result.

Here the science stops and the values start. Science can estimate consequences: who gets sick, how fast resistance spreads. It cannot choose between the patient in front of you and the patient you will never meet. How strictly should antibiotic use be controlled? That is your Claim.

NOW OPEN THE PACKET TASK

Now open the Tuesday day page, Part 2, step 1: read the clinic scenario, then “Write your Claim: how strictly should antibiotic use be controlled?” Add a Reason and Evidence about resistance and patient need, trade with a partner who weighs individual access differently (minutes 25 to 40), write the Rebuttal, and submit one PDF by the end of class. The worked example uses a different question (a needle exchange) so you can borrow its structure, never its answer (R9).

What this lesson was trying to teach

Resistance is evolution in the bacterial population: the drug and the patient stay the same while the bacteria change, so every dose carries a cost shared by people who never took it. The skill is a CER that separates what science can estimate from what values decide, with a rebuttal that answers the strongest opposing rule.

PLTW connection. In myPLTW, open Medical Interventions > Lesson 1.2 Antibiotic Treatment > Activity 1.2.1 Antibiotic Therapy, then review the CER rubric for the stewardship debate. Today opens Lesson 1.2. Tomorrow's day page says that activity asks you to apply how antibiotics act to the case patient; today's CER practices the judgment underneath it, deciding when an antibiotic is the right intervention.

If we had the full lab

Tuesday was a debate, so nothing was measured in class. This is the lab work that sits behind the decision in a real clinic and hospital.



Figure S2b. The test behind the decision: a throat swab can go to a rapid test during the visit or to the lab for culture.

1. For a sore throat, a clinician swabs the back of the throat with a sterile swab.
2. A rapid antigen detection test gives its result during the visit.
3. A throat culture grows whatever bacteria the swab picked up on an agar plate. The CDC calls throat culture the gold standard.
4. For children and teens, CDC guidance says a negative rapid test should be followed by a back-up throat culture, and the clinic contacts the family and starts antibiotics if that culture is positive.
5. CDC's instruction for a viral sore throat: do not treat it with antibiotics.
6. In a hospital, CDC's Core Elements of Hospital Antibiotic Stewardship Programs call for a physician leader and a pharmacist leader, actions such as prospective audit and feedback (reviewing antibiotic orders and advising the prescriber) or preauthorization (approval before certain drugs are given), tracking of antibiotic use and resistance, reporting back to staff, and education.

Indicator and safety. The rapid test shows its own result; the culture's indicator is bacteria growing on the plate. The person taking the swab wears gloves, a mask, and eye protection.

How it connects. The back-up culture is Monday's sensitivity idea in action: when a quick test can miss real cases, a more certain test covers the gap. A stewardship team is Tuesday's CER turned into a job.

Paper Circles on a Living Lawn

Today the question moves from “what is it?” to “what will stop it?”

Your plate arrives ready: a clear plastic **petri dish (R10)** holding a layer of agar, a firm gel that feeds bacteria. The plates for this lab are Mueller-Hinton agar, the same kind hospitals use for this test, and a teaching strain of bacteria has already been spread across the whole surface. You cannot see those bacteria yet. After a day in a warm incubator they will grow into a **lawn (R11)**, one cloudy film from edge to edge.



Figure S3. Placing antibiotic disks: forceps in one hand, the lid held low as a shield in the other, goggles and gloves on.

First, before anything opens, goggles and gloves go on and you label the bottom of the plate, the base, never the lid (A1). Then the careful part. You lift the lid just enough, tilted like a shield, and with forceps you set down small paper **antibiotic disks (R12)**, each soaked with a different drug, each pressed flat against the agar. That is **aseptic technique (R17)** at work: every second the lid is up is a second for stray microbes to land.

Now the invisible part. The moment a disk touches the moist agar, the drug starts seeping out of the paper and spreading into the gel. This spreading is diffusion: molecules move from where they are crowded to where they are not. Close to the disk the drug is strong. A little farther out it is weaker. Farther still it is thin. Meanwhile the bacteria try to multiply everywhere at once.

The goal of this test, called disk diffusion or the Kirby-Bauer test, is to identify which antibiotics can stop this organism, and the indicator is geography. Where the drug is strong enough, bacteria cannot grow and the agar stays clear. Where it has spread too thin, the lawn grows. By Thursday some disks will sit inside a clear circle, the **zone of inhibition (R13)**, whose edge marks where the drug became too dilute to stop this organism. The plate turns an invisible concentration gradient into a ring you can measure with a ruler.

That edge leads to one of this week's key numbers, the **MIC, or minimum inhibitory concentration (R14)**: the lowest concentration of a drug that stops visible growth. Hold it until Thursday. Two facts from the day page travel with it: each antibiotic diffuses through agar at its own rate, and each disk carries its own amount of drug. So every drug is read against its own row of the **zone-size chart (R15)**.

Then you tape the lid shut and set the plate in the incubator lid down (R16), so drops of condensation fall onto the lid instead of the lawn. Zones need 16 to 24 hours to form, so nothing can be measured today. What you can do today is predict: which zone will be widest, and why? That prediction, with its because, is yours to write.

NOW OPEN THE PACKET TASK

Now open the Wednesday day page and read the safety rules in Part 4 first; wait for Mr. Mendoza's approval. Then Part 2, step 1: "Put on goggles and gloves and label the bottom of your plate with your period and code, the date, and where each antibiotic disk goes." Minutes 30 to 50: make the setup record (plate map, labels, a prediction for each disk) and submit it as one PDF. Minutes 50 to 65: set up the empty table for Thursday, one row per disk, with zone (mm) and zone rank.

What this lesson was trying to teach

A clear zone is a readout for one drug on one organism, judged against that drug's own cutoff and never against another drug's zone. The skill is setting up a labeled, safely handled plate and committing to a prediction before any data exist.

PLTW connection. In myPLTW, open Medical Interventions > Lesson 1.2 Antibiotic Treatment > Activity 1.2.1 Antibiotic Therapy. The day page says to apply what you know about how antibiotics act to the case patient, with antibiotic selection and justification due today. The plate practices the evidence under that choice: a clinician picks an antibiotic after the lab reports which drugs stop the organism.

If we had the full lab

A hospital lab runs the same test on a patient's own organism, with every variable standardized:



Figure S3b. A clinical disk diffusion setup: standardized bacterial liquid, a swab, Mueller-Hinton agar, a disk dispenser, and an incubator.

1. Start pure: bacteria from the patient's isolated colonies (Friday's skill) are mixed into liquid until its cloudiness matches a 0.5 McFarland turbidity standard.
2. Within 15 minutes, a sterile swab spreads that liquid over the whole Mueller-Hinton plate in three passes, turning the plate 60 degrees between passes.
3. Within 15 minutes of swabbing, disks go down at least 24 mm apart and are pressed into full contact, often with a dispenser that places several at once.
4. Plates incubate inverted at 35 °C (plus or minus 2 degrees) for 16 to 18 hours.
5. Zones are measured from the back of the plate against a black background, to the nearest whole millimeter, disk included.
6. Each zone is compared with that drug's row in the CLSI M100 breakpoint tables (or the FDA's interpretive criteria) and reported as susceptible, intermediate, or resistant.
7. Many labs also measure the MIC directly: in broth microdilution, wells hold the drug in twofold dilutions, each gets a standardized amount of bacteria, the plate incubates at about 35 °C for 18 to 24 hours, and the MIC is the lowest

concentration with no visible growth. Automated instruments such as VITEK 2 and Phoenix do this at scale and report approximate MIC values.

Safety. Gloves, eye protection, and every plate and swab decontaminated before disposal.

How it connects. Our plates skip the first two steps: they arrive with a non-disease-causing lab strain already spread as a lawn, and you place disks by hand. Measuring and reading against a chart are exactly what you do Thursday.

The Valley, the Stream, and the Taped Lid

Thursday has two halves, and they turn out to be the same story.

For the first 40 minutes John Carroll runs the room. You walk in with your preparation assignment, and your side is handed to you, not chosen. It may be the side you disagree with. The day page explains why: “A position you cannot argue against is a position you do not yet hold.”



Figure S4. The debate scenario: an isolated valley, a treated herd, a shared stream, and researchers sampling the water (an illustration of the scenario, which is fictional).

Here is the scenario as the day page tells it. An isolated mountain valley has clear streams and no industry. A bacterial outbreak hits the local livestock, so the community treats the herds with a large course of antibiotics. Weeks later, researchers find antibiotic traces in the stream water, a shifted bacterial population, and new antibiotic resistance genes.

Read it as a chain. First, drugs went into animals. Then some of the drug reached the water. The researchers' goal was to identify whether treatment on the pasture changed life in the stream. The scenario does not say which tests they ran; it reports what they found. Tuesday tells you why the finding matters: wherever an antibiotic meets bacteria, the susceptible ones lose ground and the resistant ones gain it.

The day page gives one opening argument per side. For a ban: even low concentrations of antibiotics apply selective pressure, favoring resistant strains and spreading resistance genes through the environment and into the food chain. Against a ban: antibiotics do break down in the environment, through biodegradation (by living things), hydrolysis (by water), and photolysis (by light), at rates that depend on pH, temperature, and sunlight. Your preparation assignment carries the rest. Which argument survives contact with the other is what the 40 minutes will find out; this packet does not decide it for you (R20, R9).

At minute 40 the room changes. Your plate has incubated since Wednesday. You hold it up, taped shut, and read it through the lid, because an incubated plate is never opened. Where the lawn grew, the agar is cloudy. Around some disks there is a clear circle.

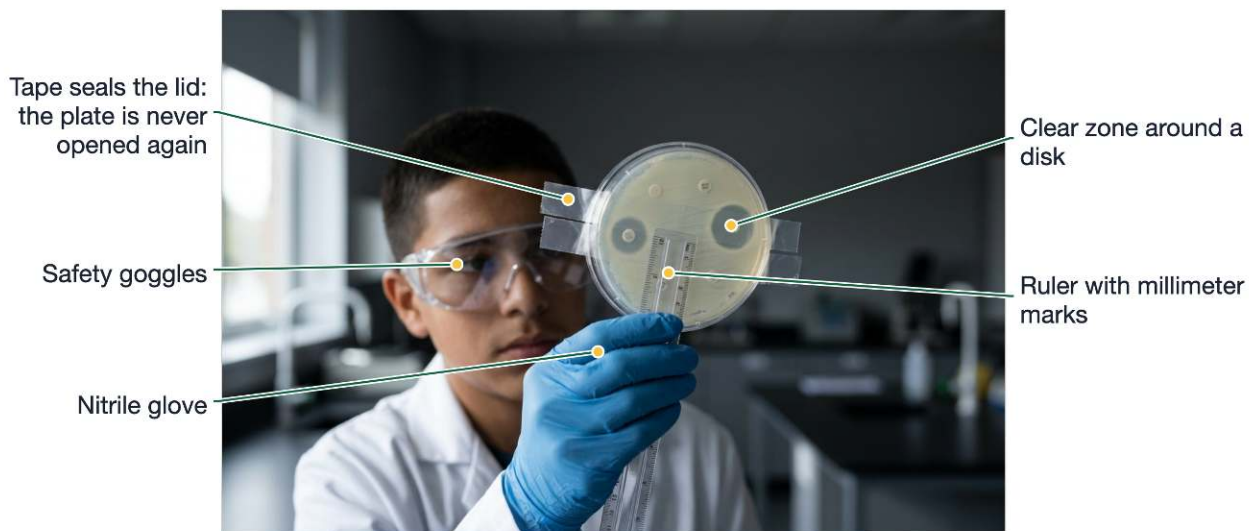


Figure S4b. Reading an incubated plate through the taped lid, ruler held against the plate.

Measuring it is simple and exact (R13). Lay the ruler across the zone so it passes through the center of the disk, and read the full diameter, edge to edge, disk included, in whole millimeters. A zone 24 mm across is recorded as 24, not 9 on each side. If the lawn grows right up to the disk, there is no zone: record 6 mm, the disk's own width. No zone can be smaller than 6 mm.

Then read each drug against its own row of the zone-size chart your teacher hands out with the plates (R15). Where the chart has a row for your organism and that drug, millimeters become susceptible, intermediate, or resistant. Where it has no row, write “no cutoff for this organism” and rank the zones by size: a spectrum demonstration, not a resistance result.

One sentence remains, and it is yours: what does a larger zone say about the MIC (R14) for that same drug, and why does it say nothing when you compare two different drugs? Wednesday's story gave you the gradient. Put it together.

NOW OPEN THE PACKET TASK

Now open the Thursday day page. Minutes 0 to 40: the debate (Part 2, steps 1 to 7), ending with where you stand now and what moved you. Minutes 40 to 50: “read the disk-diffusion plate you set up last class ... through the taped lid (never open it), measure each zone of inhibition in millimeters, and finish your data table.” Put the finished table on the last page of your worksheet PDF and upload one PDF by the end of class. Absent Wednesday? Use the practice zone record in Part 2 of the day page and write “practice data” at the top.

What this lesson was trying to teach

Two skills in one block. The debate: argue an assigned side, state the other side's best case in a form its holders would accept, and keep evidence separate from values. The plate: a measurement means something only when it is taken the same way every time and read against the right standard.

PLTW connection. The first 40 minutes belong to John Carroll. For the second half, continue Activity 1.2.1 in myPLTW (Medical Interventions > Lesson 1.2 Antibiotic Treatment > Activity 1.2.1 Antibiotic Therapy), picking up where Wednesday stopped. Your zone table is the kind of evidence an antibiotic choice rests on.

If we had the full lab

Your plate is a real clinical test in miniature. A hospital lab reads the same kind of plate this way:

1. The plate is read from the back against a black, non-reflecting background, with sliding calipers or a ruler.
2. Each zone is recorded to the nearest whole millimeter, disk included.
3. Each zone is compared with that drug's row in the CLSI M100 breakpoint tables (or the FDA's interpretive criteria).

4. The report the doctor sees lists each drug as susceptible (S), intermediate (I), or resistant (R) for that patient's organism.

Safety. Incubated plates stay taped shut. Before disposal they are flooded with 10% bleach for at least 20 minutes (or autoclaved), then sealed in a biohazard bag.

How it connects. A hospital reads a patient's own organism, grown pure. Our plates use a teaching strain, which is why your chart may have no row for it. As for the valley: the scenario reports resistance genes but not how they were found, so this packet does not invent a method. One tool you already know fits: resistance genes are stretches of DNA, and DNA can be compared against known sequences, the BLAST skill from September.

The Invisible Crowd

Friday starts quiet: pencils, paper, 40 minutes, the Unit 1 Test. Then the benches open for a rehearsal.

On Monday, October 5, you will grow living bacteria from a sample. The goal will be to identify what grows, and that only works if what grows came from your sample and nothing else. A plate that picks up a stray microbe tells a false story, and you cannot see the lie until the colonies appear.



Figure S5. The dry run: lid lifted partway like a shield, cold loop angled in underneath. No flame today.

Here is the problem, in the order it hits you. First, microbes are everywhere you cannot see them; a bench can look spotless and still carry them. Next, an agar plate is a feast: anything that lands on it and can grow will grow, and within a day or two each landing becomes a **colony (R11)**, a visible pile of cells descended from one. So the goal of **aseptic technique (R17)** is to name every route by which something other than your sample could reach the agar, and to block each one.

The tools are simple. An **inoculating loop (R18)** is a thin wire ending in a small ring, set in a handle. In a live lab the wire is heated in a flame until it glows orange-red, which kills anything on it, and then it cools for a few seconds so it will not kill the sample it is about to pick up. The plate's lid is lifted only partway, tilted like a shield.

Today there is no flame and no live culture. You practice the motions dry, with a cold loop and an empty dish, until your hands know them. Then you write: the ways a culture could be contaminated, the steps in order, why the lid stays down, the safety rules for cultures and waste (R19), and your prediction of how a contaminated plate would differ from a clean one. Every one of those answers is yours; the story stops here on purpose.

NOW OPEN THE PACKET TASK

Now open the Friday day page. After the test, read the safety rules in Part 4 (“Today is a dry run: no flame and no live cultures.”), then Part 2, step 1: “List the ways a culture could get contaminated, from air to hands to tools.” Work the six steps in order, using the four-motion figure on the day page for your numbered list. Submit the pre-lab as one PDF by 11:59 PM tonight, and bring it to the culturing lab on Monday, October 5.

What this lesson was trying to teach

The biggest contamination routes are ones you cannot see, so a clean-looking bench proves nothing about a clean plate. Aseptic technique keeps a culture pure so its results mean something. The skill: plan and rehearse every physical move before live cultures are involved.

PLTW connection. In myPLTW, open Medical Interventions > Lesson 1.2 Antibiotic Treatment > Project 1.2.3 Attack of the Superbugs and review the culturing protocol before Monday's lab. Today's dry run rehearses the moves that protocol depends on.

If we had the full lab

In a working microbiology lab, the same moves happen with live cultures:

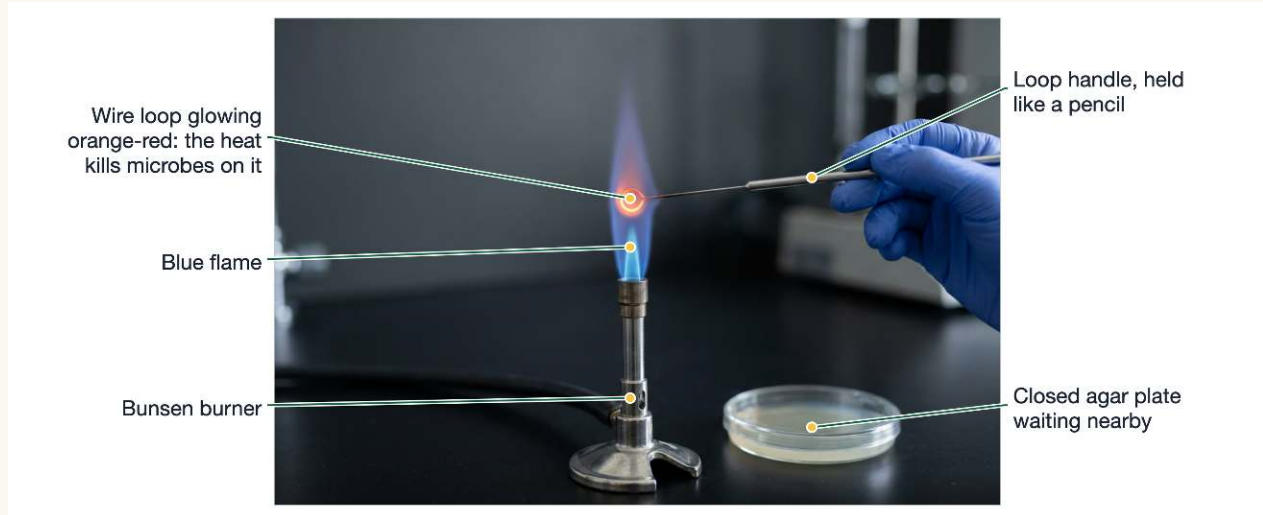


Figure S5b. In a live lab (not today): the wire loop glows orange-red in the burner flame, which sterilizes it.

1. A Bunsen burner heats the wire loop until it glows red; the loop cools before touching the culture and is flamed again afterward so nothing rides out on it. Culture-tube mouths are passed through the flame too.
2. The streak plate: the sample is spread over one section of the agar, the loop is sterilized, then dragged from that section into the next, and again into a third. Each pass carries fewer cells, until the last section has cells far enough apart that each grows into its own colony.
3. Plates incubate inverted at the organism's temperature for 24 to 48 hours.
4. The indicator is the colonies themselves: each visible dot is millions of cells that grew from one, which makes single invisible cells countable.

Safety. Everything that touched a culture is soaked in disinfectant or sterilized in an autoclave before disposal. At our benches, used plates are flooded with 10% bleach for at least 20 minutes, then sealed in a biohazard bag.

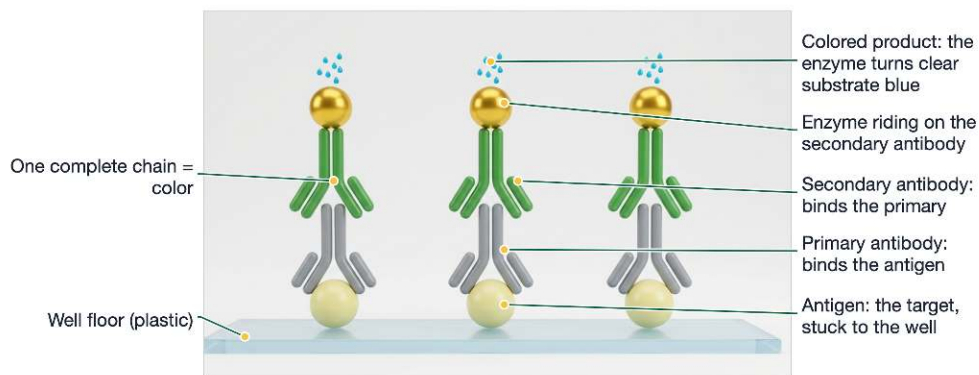
How it connects. In a hospital, streaking is the step that turns a patient sample holding many kinds of microbes into one pure organism, which is what Wednesday's disk test and an MIC test need. Friday's dry run and Monday's live streak are the classroom version of that exact step.

Reference pages R1 to R20

One tool or word per page section, assuming you have never seen it before. Each gives a plain definition, what it looks like, what it is for, how to read it, and a common mistake.

R1 ELISA

Used this week: Monday (S1)



The ELISA chain inside one well, drawn as a model (molecules are far too small to see).

Plain definition

ELISA stands for enzyme-linked immunosorbent assay: a test that uses antibodies to find one target molecule in a sample and an enzyme to turn that find into color.

What it looks like

A strip or plate of small wells. At the end, some wells are colored and some are nearly clear.

What it is for

Detecting whether a sample holds a particular antigen, such as a sign of infection.

How to read it

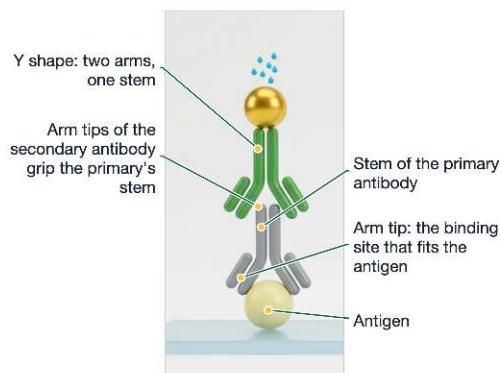
Controls first (R4). Then score each well's color on its own (R3). Then apply your stated cutoff (R5). Color appears only where the whole chain (antigen, primary antibody, enzyme-carrying secondary antibody) survived the washes.

Common mistake

Treating any color as a positive. A rushed or skipped wash leaves loose enzyme behind and makes color with no antigen at all.

R2 Antigen and antibody (primary and secondary)

Used this week: Monday (S1)



One stack from the ELISA model: antigen, primary antibody, secondary antibody with its enzyme.

Plain definition	An antigen is a substance an antibody can bind. An antibody is a Y-shaped protein made by the immune system; the tips of its two arms form binding sites that fit one particular part of one antigen.
What it looks like	Too small to see. Drawings show a Y with two arms and a stem.
What it is for	In your body, antibodies tag invaders. In an ELISA, the primary antibody (added first) binds the antigen, and the secondary antibody (added second) binds the primary and carries the enzyme tag.
How to read it	“Primary” means it touches the target directly. “Secondary” means it grips the primary and makes it visible.
Common mistake	Assuming binding is perfect. An antibody can sometimes bind a different target (cross-reaction), one reason a specific test is still not an error-free test.

R3 ELISA well, plate strip, and the color scale

Used this week: Monday (S1), A2



The four points of the scale, shown on one strip (an illustration, not your plate).

Plain definition	A well is one tiny plastic cup in a plate. A strip is a row of wells. Each well is named by its row letter and column number, such as A1 or B4.
What it looks like	See the figure: eight wells in two rows, each filled with liquid that ends up anywhere from nearly clear to dark blue.
What it is for	Running several samples side by side under identical conditions.
How to read it	Score each well on its own, against a white background. Monday's figure uses a 0 to 3 intensity scale; your September 23 record used four words: Nearly clear, Light, Medium, Dark. Both run lightest to darkest. Say in your report which number you gave each word.
Common mistake	Treating the scale as an amount. The words and numbers are an observation scale, in order, not a concentration.

R4 Positive and negative controls

Used this week: Monday (S1)

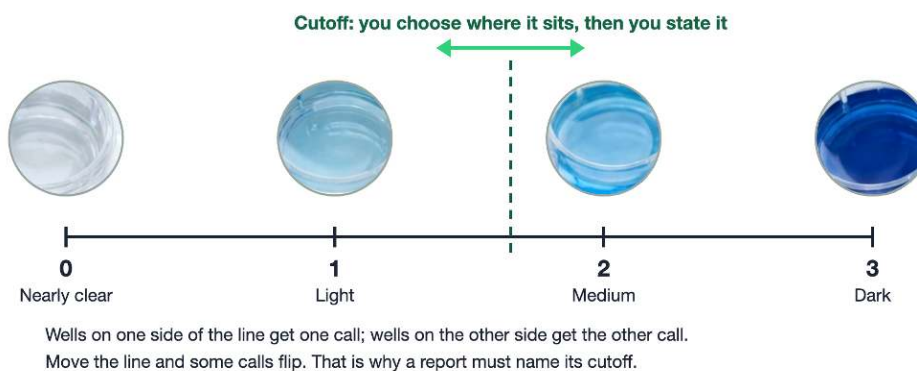


What each control should look like when a run works.

Plain definition	A control is a well with a known expected result, run exactly like every sample. The positive control holds material that should complete the chain, so it should develop color. The negative control holds no antigen, so it should stay nearly clear.
What it looks like	Two wells on the same strip as your samples, labeled in your record.
What it is for	Proving the run could make color (positive control) and did not make color where it should not have (negative control).
How to read it	Read both before any sample well. Both behaved: the sample wells can be read. Negative control colored: the strip is flagged; repeat it or ask for review. Positive control stayed clear: the chain never completed, so a clear sample well means nothing.
Common mistake	Subtracting the negative control's color and carrying on. Also: a clean control pair lets you read the other wells; it does not make any sample well positive or negative.

R5 Cutoff

Used this week: Monday (S1)



The 0 to 3 scale, built from real well photos, with a movable cutoff. Where it sits is your decision.

Plain definition	The cutoff is the line on the color scale where a shade becomes a call: wells on one side are called negative, wells on the other side positive.
What it looks like	On Monday's figure, a dashed, movable line across the 0 to 3 scale.
What it is for	Turning color, which is continuous, into calls you can report.
How to read it	Choose it, then state it beside every call. The day page's trap: moving the cutoff moves sensitivity and specificity in opposite directions.
Common mistake	Leaving it unstated, or treating color as a simple yes or no.

R6 Sensitivity, specificity, and the reference standard

Used this week: Monday (S1)

	What the test said	
	Test positive	Test negative
Truly HAS the condition (by the reference standard)	a True positive caught	c False negative missed
Truly does NOT have it (by the reference standard)	b False positive false alarm	d True negative cleared

Sensitivity = $a \div (a + c)$: of the people who truly have it, the share the test caught.

Specificity = $d \div (b + d)$: of the people who truly do not have it, the share the test cleared.

Each rate needs a reference standard: some trusted way to know who truly has the condition.

The two-by-two table from September 25, with its four cells named.

Plain definition

Sensitivity is the share of people who truly have a condition whose test comes back positive: the ones caught. Specificity is the share of people who truly do not have it whose test comes back negative: the ones cleared. A reference standard is a trusted, independent way (such as a confirmatory test) to know who truly has the condition.

What it looks like

A two-by-two table: rows for the truth, columns for the test result.

What it is for

Judging how often a test will be wrong, and in which direction.

How to read it

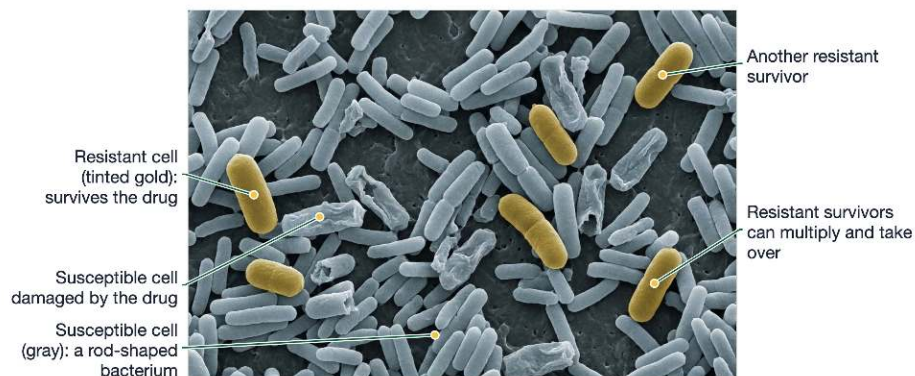
Sensitivity = $a \div (a + c)$, using only the row of people who have the condition. Specificity = $d \div (b + d)$, using only the row of people who do not.

Common mistake

Mixing them up. Low sensitivity means missed cases (false negatives); low specificity means false alarms (false positives).

R7 Antibiotics and antibiotic resistance

Used this week: Tuesday (S2), Thursday (S4)



Selection during treatment (false-color illustration): gray susceptible cells, some damaged; gold resistant survivors.

Plain definition

An antibiotic is a drug that kills bacteria (bactericidal) or stops them from multiplying by attacking structures only bacteria have, such as the peptidoglycan cell wall. Antibiotic resistance is when bacteria survive a drug that used to kill them, because a mutation or a gene picked up from other bacteria (horizontal gene transfer) protects them, and the survivors pass that protection on.

What it looks like

Invisible without a microscope. The figure is a false-color illustration.

What it is for

Understanding why one person's antibiotic use can affect people who never took it.

How to read it

Follow the chain: the drug arrives, susceptible cells die, resistant cells survive, survivors multiply. "The drug itself does not weaken; the bacterial population changes."

Common mistake

Saying the patient became resistant, or that antibiotics treat viruses. Viruses are not cells and have no cell wall to attack.

R8 Antibiotic stewardship

Used this week: Tuesday (S2)



A hospital stewardship team at work (illustration).

Plain definition	Coordinated programs and habits that promote appropriate antibiotic use, the right drug and only when it helps, to slow resistance.
What it looks like	In a hospital, a stewardship team led by a physician and a pharmacist that reviews antibiotic orders, tracks use and resistance, and educates staff.
What it is for	Keeping antibiotics working for the next patient.
How to read it	A stewardship rule answers three questions: who decides, when is an antibiotic used, and how strictly is that enforced?
Common mistake	Treating antibiotic use as a private choice. Resistant bacteria bred in one person can spread to family, classmates, and strangers.

R9 CER, rebuttal, claim ceiling, and limitation

Used this week: Tuesday (S2), Thursday (S4), Monday report

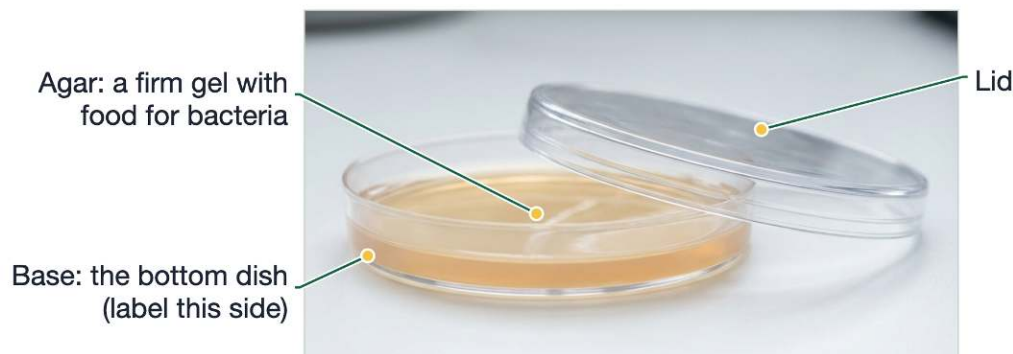


A structured debate: claims with evidence, a facilitator, and a worksheet that records both sides.

Plain definition	CER is Claim (one sentence that answers the question), Evidence (specific facts or data), Reasoning (the scientific rule that connects the evidence to the claim). A rebuttal answers the other side's strongest point directly. A claim ceiling is the highest claim your evidence can support. A limitation names one specific way your method could make the result wrong.
What it looks like	Labeled paragraphs: Claim, Evidence, Reasoning, Rebuttal.
What it is for	Every written product this week.
How to read it	If a rebuttal only repeats your own claim, it has not answered anything. Try the day page's frame: "That would be true if ___, but ___." Every day page states its claim ceiling, for example that the evidence "cannot prove causation, diagnose a real patient, or justify action outside this room."
Common mistake	Answering the other side's weakest point, or writing "human error" as a limitation. Name what about the procedure or instrument caused the problem.

R10 Petri dish and agar plate

Used this week: Wednesday (S3), Friday (S5), A1



An empty sterile agar plate with its lid set beside it.

Plain definition	A petri dish is a shallow, round, clear plastic dish with a lid. An agar plate is a petri dish whose base is filled with agar, a firm gel mixed with nutrients so bacteria can grow on its surface. This week's plates are Mueller-Hinton agar, the standard medium for disk diffusion.
What it looks like	A clear dish holding a smooth, flat, pale amber gel.
What it is for	Growing bacteria where you can see the result.
How to read it	Label the base (the bottom), small, near the edge. Incubate it lid down.
Common mistake	Writing on the lid (lids come off and get swapped), or opening the plate longer than needed.

R11 Bacterial lawn and colony

Used this week: Wednesday (S3), Friday (S5)



Left: a lawn. Right: separate colonies on bare agar.

Plain definition	A colony is a visible cluster of identical microbes on a plate, all descended from a single cell. A lawn is bacteria spread so densely that the colonies merge into one continuous film.
What it looks like	A lawn is an even, cloudy layer. Colonies are separate dots.
What it is for	A lawn lets clear zones show on the disk diffusion plate. Separate colonies, on the October 5 streak plate, can be counted and described.
How to read it	Describe colonies by size, color, shape, and edge. A lawn is judged by where it did not grow.
Common mistake	Reading a smooth lawn as "nothing grew." A lawn is growth everywhere.

R12 Antibiotic disk and forceps

Used this week: Wednesday (S3), A1

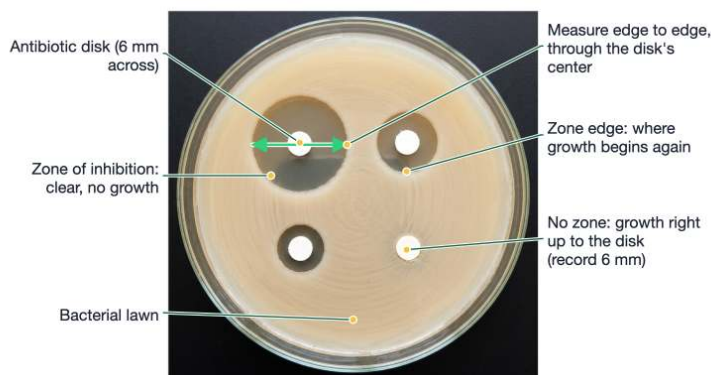


Forceps place a disk; the other disks sit well apart.

Plain definition	An antibiotic disk is a small paper disk, 6 mm across, soaked with a set amount of one antibiotic and marked with an abbreviation. Forceps are flat tweezers for moving a disk without touching it by hand.
What it looks like	A white paper dot about the size of a pencil eraser.
What it is for	Delivering one drug to one spot on the lawn.
How to read it	Record each disk's abbreviation and spot on your plate map (A1). Press each disk flat so it touches the agar all over.
Common mistake	Sliding a disk after it touches the agar. The drug starts spreading at once, so a moved disk smears its zone.

R13 Zone of inhibition, and how to measure it

Used this week: Wednesday (S3), Thursday (S4)

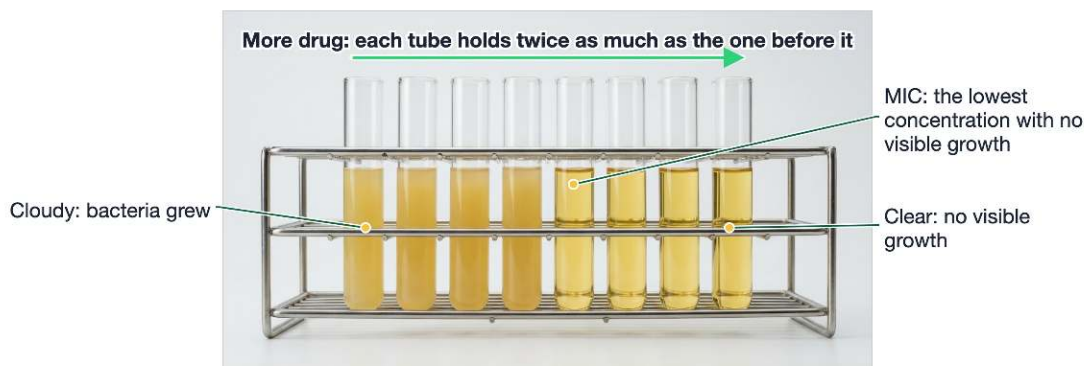


Reading a disk diffusion plate (an illustration; zone sizes here are not your data).

Plain definition	A clear ring on a bacterial lawn around an antibiotic disk where the drug has killed the bacteria or stopped their growth.
What it looks like	A clear circle, dark against a dark background, with the disk at its center.
What it is for	Reading how well one drug stops one organism.
How to read it	Measure the full diameter through the disk's center, edge to edge, disk included, in whole millimeters. A zone 24 mm across is 24 mm, not 9 on each side. Growth right up to the disk means no zone: record 6 mm. Every zone is at least 6 mm and a whole number.
Common mistake	Measuring from the disk's edge to the zone's edge, or ranking different drugs by zone size.

R14 MIC (minimum inhibitory concentration)

Used this week: Wednesday (S3), Thursday (S4)



A broth dilution series (illustration): the MIC is the first tube with no visible growth.

Plain definition	The lowest concentration of an antibiotic that prevents visible growth of an organism, usually given in micrograms per milliliter ($\mu\text{g/mL}$).
What it looks like	In the test that measures it directly, a row of tubes or wells: cloudy where bacteria grew, clear where they did not.
What it is for	Knowing how little of a drug is enough to stop this organism.
How to read it	Read from the least drug to the most. The first clear tube is the MIC. A disk plate does not measure MIC directly; your Thursday sentence explains what a zone can and cannot hint about it.
Common mistake	Treating a lower MIC for one drug as proof that drug beats another. Each drug is judged against its own breakpoints.

R15 Zone-size chart and breakpoints (S, I, R)

Used this week: Thursday (S4)

How one row of a zone-size chart reads (made-up drug and numbers, for practice only)

Drug	Resistant (R)	Intermediate (I)	Susceptible (S)
Drug Q (made up)	12 mm or less	13 to 16 mm	17 mm or more

Example: a Drug Q zone measures 15 mm. Find Drug Q's own row, find the range that holds 15, then read the letter at the top of that column: I.

Every drug has its own row. Never judge one drug's millimeters with another drug's row.

No row for your organism? Write "no cutoff for this organism" and rank the zones by size: that is a spectrum demonstration, not a resistance result.

How one row reads. Drug Q and its numbers are made up for practice; use the chart your teacher hands out.

Plain definition	A zone-size chart gives, for each drug and organism, the zone diameters that count as susceptible (S), intermediate (I), or resistant (R). Those cutoffs are called breakpoints. Hospitals use the CLSI M100 tables.
What it looks like	A table with one row per drug and three columns of millimeter ranges.
What it is for	Turning millimeters into a reading for one drug.
How to read it	Find that drug's own row, find the range that holds your measurement, read the letter. Susceptible: the drug is likely to work at a standard dose. Resistant: it is likely to fail. Intermediate: in between.
Common mistake	Reading one drug's zone against another drug's row, or inventing a row when your organism has none.

R16 Incubation

Used this week: Wednesday (S3), Thursday (S4)



Taped plates stacked on the shelf of a small lab incubator.

Plain definition	Keeping cultures warm at a set temperature for a set time so bacteria can grow. An incubator is the warm box that does it; 37 °C is common for lab strains.
What it looks like	A metal cabinet with shelves, a light, and a fan.
What it is for	Giving bacteria time to grow into a lawn or colonies. Zones need 16 to 24 hours.
How to read it	Tape the lid shut. Incubate lid down (inverted), so condensation drips onto the lid instead of the lawn. Incubated plates stay taped and are read through the lid.
Common mistake	Incubating lid up, or opening an incubated plate to get a better look. Never open an incubated plate.

R17 Aseptic technique and contamination

Used this week: Wednesday (S3), Friday (S5)

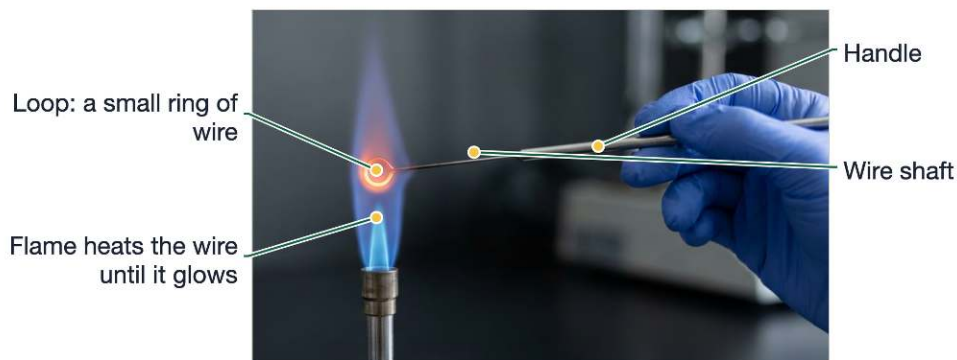


The lid as a shield: opened a crack, for seconds, with the loop entering underneath.

Plain definition	Aseptic technique is a set of careful practices that keep microbes out of a sterile area, protecting samples, cultures, and people. Contamination is any microbe that reaches your culture that did not come from your sample.
What it looks like	Small, deliberate moves: lids lifted only partway, tools sterilized, benches disinfected.
What it is for	Keeping a culture pure so its results are valid. A contaminated plate cannot support a conclusion about a single strain.
How to read it	Judge your practice by what you cannot see. The day page's trap: the biggest routes are invisible, so a clean-looking surface proves nothing.
Common mistake	Trusting how clean a bench, a hand, or a tool looks.

R18 Inoculating loop

Used this week: Friday (S5), October 5 lab



An inoculating loop being flame-sterilized (a live-lab step, not part of Friday's dry run).

Plain definition	A thin metal wire ending in a small ring, set in a handle, used to pick up a tiny amount of bacteria and spread it on agar.
What it looks like	See the figure: handle, wire shaft, loop.
What it is for	Moving a sample onto a plate, including streaking to get separate colonies.
How to read it	In a live lab, the wire is heated in a flame until it glows, which sterilizes it, and it cools before touching the culture. The order of the four loop motions is in the figure on the Friday day page; copy it into your numbered list in your own words. Today the loop stays cold.
Common mistake	Touching a still-hot loop to a culture. The heat kills the bacteria you meant to pick up.

R19 Culture safety: PPE, biohazard, and bleach

Used this week: Wednesday (S3), Thursday (S4), Friday (S5)



A cleanup station for culture work.

Plain definition	PPE (personal protective equipment) is the gear between you and a hazard: safety goggles, nitrile gloves, a lab coat. A biohazard is biological material that could harm people.
What it looks like	Goggles, gloves, a red biohazard bag, a bleach bottle, a disinfectant spray.
What it is for	Protecting you, your classmates, and your results.
How to read it	From the day pages: disinfect the bench before and after; no food or drink; goggles and gloves on before any culture opens; treat all bacterial materials as biohazardous; flood used plates with 10% bleach for at least 20 minutes (or autoclave), then seal them in a biohazard bag; wash your hands with soap and water after removing gloves.
Common mistake	Putting used plates in the regular trash, or taking gloves off before cleanup is done.

R20 Bioethics words and stakeholders

Used this week: Tuesday (S2), Thursday (S4)



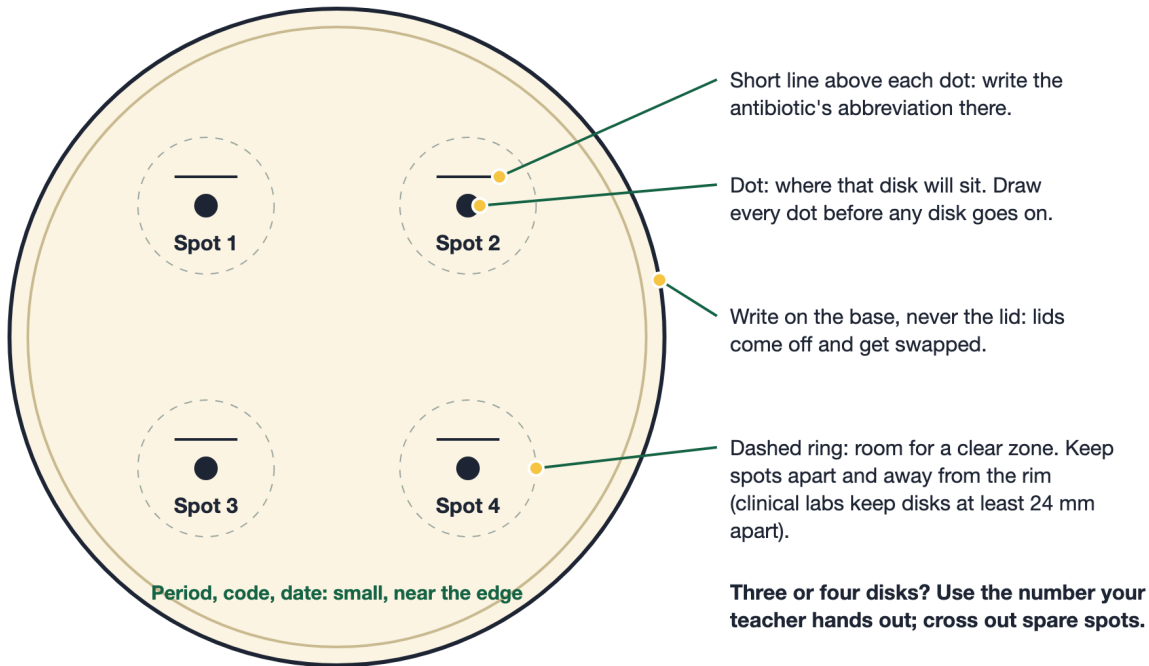
Stakeholders in Thursday's scenario (an illustration of a fictional case).

Plain definition	Bioethics weighs what we should and should not do in medicine and research. Autonomy: a person's right to make informed decisions about their own care. Beneficence: acting to benefit people. Nonmaleficence: not causing harm. Justice: sharing benefits, risks, and costs fairly. A stakeholder is anyone affected by a decision.
What it looks like	In a debate, these are the values under the arguments.
What it is for	Naming the value behind a claim so it can be weighed openly.
How to read it	Separate the scientific evidence from the value judgment, then say who benefits, who carries the burden, and what uncertainty remains.
Common mistake	Treating one principle as automatically outweighing every other one.

Labeled maps for this week's work

A1 Disk diffusion plate map

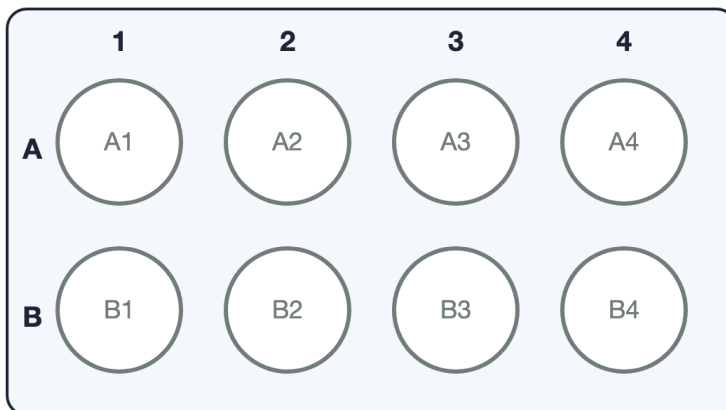
Use it on Wednesday while you label the base of your plate and build your setup record (R10, R12). It shows where things go; the labels and predictions you write are your own.



This map supports your setup record. Your labels and your predictions are your own work.

A2 Eight-well strip map for the ELISA report

Use it on Monday to name each well in your data table (R3, R4, R5). Which sample sat in which well comes from your own September 23 record.



- 1 Well ID = row letter + column number (B3 is row B, column 3).
- 2 Your record says which sample went in each well. Copy it; never guess.
- 3 Read the two control wells FIRST (R4).
- 4 Score every well on its own, against white, on the 0 to 3 scale (R3).
- 5 Then apply your stated cutoff (R5).