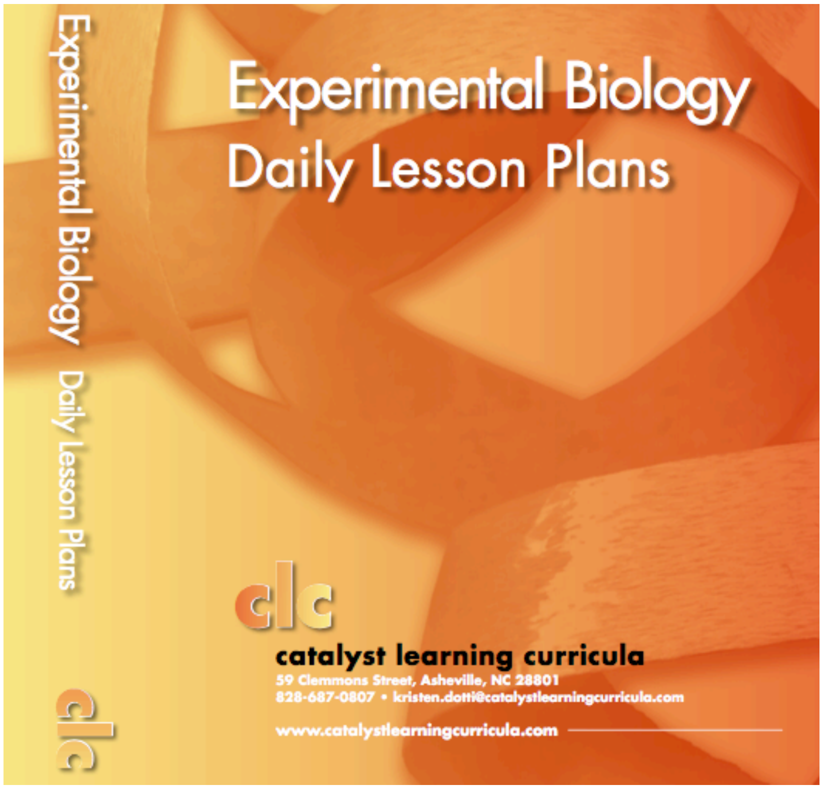

Experimental Biology Daily Lesson Plans:

A Pre-AP, Honors, IB Biology or General Biology Course Based on Inquiry Learning

(Sample Week of Lesson Plans)

The full-year curriculum includes:

- 170 sequential lesson plans covering the General Biology course requirements for all 50 states, including NGSS, college preparatory study skills and lab skills.
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Experimental Biology
Daily Lesson Plans Curriculum

A Pre-AP and General Biology Course Based on Inquiry Learning

Table of Contents

Experimental Biology Curriculum
Anatomy and Physiology Unit
(Sample Week of Lesson Plans)

Day 1

I. Topic: Immune System

II. Warm-up: 5 minutes

Prior to class, write the following on the board: "Take one petri dish of E. coli from the supply desk. DO NOT open the container. Gather with your lab group and make observations about the growth of these bacteria."

III. Activity One: Disease Transmission 45 minutes

Objectives:

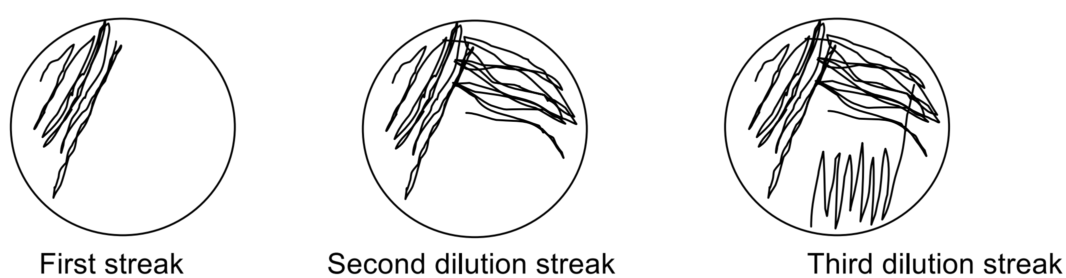
a) The learner will (TLW) examine the growth of bacteria and other potential pathogens to determine what factors affect the growth patterns of these organisms.
b) TLW practice the scientific process of observation, questioning the design of a repeatable scientific procedure.

Materials:

For the class: 5 sealed petri dishes with LB nutrient agar and various stages of bacterial growth (prepared according to step 1, below); one large spool of Parafilm; a new, disposable inoculating loop (or toothpick); one E. coli slant tube. For each lab group: 10-20 petri dishes spread with LB nutrient agar; scissors; a permanent marker.

Procedure:

1. One to two days prior to class, streak one petri dish with E. coli bacteria for each lab group. Streak each plate in a reducing pattern, such that one portion of the plate is thickly covered with bacteria colonies and other parts of the plate have less dense growth. A common streak pattern is shown below:



For the second and third streak, use a new disposable inoculating loop, toothpick or other sterile tool to reduce the number of colonies that will grow along the streak path.

2. Seal all bacteria plates with Parafilm. Label the side of each plate with the date, the medium (LB), and the species (E. coli). Allow the bacteria to grow in an incubator or in a warm, moist place out of direct sunlight. When the bacteria colonies have grown enough that white colonies can be seen throughout the regions of the plate that have been streaked, move them to the refrigerator to inhibit further growth.
3. On the day of this lesson plan, take the bacteria out of the refrigerator and place them on the supply desk for collection as the students enter class.
4. After the students have had a few moments to make observations about the growth of the bacteria on the prepared plates, open the discussion by asking some of the following questions:
    a. Where are E. coli found naturally? What is their host organism?
    b. What are the habitat needs for E. coli?
    c. What do you think limits the growth of E. coli?
    d. Why do you think they are able to grow in the petri dishes?
    e. If you were trying to deter the growth of E. coli on your food, your kitchen counters, or on your hands, how would you attempt to do so?
    f. What other pathogens are normally on your hands or your kitchen counters?
5. Tell the students they are going to participate in a class-designed experiment using nutrient plates. Tell them that as a class they will be gathering data for the following question: Do we transmit more pathogens with dry, unwashed hands; wet, unwashed hands; wet, washed hands; or dry, washed hands?

Special Note: Rather than conduct this experiment with the class, you may decide to allow the students to conduct experiments of their own design, with their lab groups. If so, realize that there are many hazardous pathogens that could potentially grow on a simple LB nutrient agar. If you allow the lab groups to work independently, it will be imperative that you approve the procedure, monitor each experiment closely, and require that all petri dishes remain sealed until the moment they are inoculated, then resealed and never opened again. Finally, all petri dishes must be properly disposed of by you (the teacher), using bleach or an autoclave to sterilize the cultures.

6. Ask the students to each write down a hypothesis that answers the question in step 5, above. In other words, what results do they think they will observe? Insist that every time your students write a hypothesis, they include a "because…" statement that explains why they think their educated guess is rational and scientific. Let them know that the "because" part is the part you are grading, since it helps you see if they are thinking scientifically. Help your students understand that, like all scientists, they are still learning about the world around them and so they are not expected to understand something before they have had time to explore it. So, it is not the correctness of the hypothesis you

are grading, but the thinking behind the hypothesis. (Please see the Special Note at the end of this lesson plan.)

7. Ask each lab group or pair of students to come up with a scientific procedure to test the class question. Realize that there is no need to add any pathogens to the hands of any of the students who participate in an experiment to test the question above; there will already be plenty of bacteria and yeast spores on the students' hands for use in the experiment. So, you will NOT use the E. coli slant or any other prepared bacteria samples for any of the student-designed experimentation.
8. Ask the students, groups or pairs to share their procedure with the class in a peer-review fashion. Be sure all students ask questions and clarify each procedure that is proposed (resulting in the best procedure possible) before moving on to the next group. Do not allow the students to pass over any obvious flaw in a procedure, even if stopping to fix the procedure means that the class will spend more than one day on this step of the process.
9. When all the procedures have been presented and revised where necessary, ask the students to vote on the procedure they think has the greatest scientific strength—clear, repeatable, good sample size, limited variables, etc.
10. Once the class has decided on a particular procedure, ask the winning group to choose one person to type up the procedure for homework and bring in a printed copy to share with the class on the next class day. The student who types and prints the procedure will be exempt from the homework described in the next step and mentioned again, below.
11. Ask the students to each design an appropriate data collection chart to present to the class. You may require that all data charts be printed from a computer so that they're legible when shared during the next class period.

Special Note: When the lab is conducted tomorrow, you may see results that you did not expect. For the most part, dry hands convey fewer particles, so there will be less growth on the "dry hands" media plates than on the "wet hands" media plates. Your students might predict this and they are likely to readily accept it. However, the "washed hands" might reveal more, the same amount, or only slightly less conveyed particles because there are bacteria and fungal particles in the air and on the paper towel. Some students have a hard time believing that bacteria and fungi are so readily available for repopulation on their hands after washing and that soap does not remove all organisms. You might notice that there are fewer fungal growths (yellow glossy plaques or yellow/white stringy masses) than bacterial colonies (white fuzzy dots) after washing. Do not let on as to the probable results; allow the students to guess and explain their thinking based on their own logic and prior knowledge. At some point the students will need to face their preconceptions and misconceptions when they are writing their conclusions, and you may find they have a hard time giving up their ideas. Below is a photo of two series of plates from this experiment. In this case, the towel that was used to dry the washed hands was a laundered bathroom hand towel hung on a rack one day before the experiment.

HW: Ask the students to each write the Methods section of their lab report, including a list of materials needed and the step-by-step procedure they will follow.

Experimental Biology Curriculum
Anatomy and Physiology Unit

Day 2

I. Topic: Nonspecific Immune Response

II. Warm-up: **5 minutes**

Prior to class, write the following on the board: "Collect the necessary supplies for your lab group and a copy of the lab procedure, and prepare to conduct the Disease Transmission Lab experiment. Read the procedure to make sure it is written in the best way possible to address the question of interest. Do not begin the procedure until told to do so."

III. Activity One: Disease Transmission **30 minutes**

Objectives:

a) The learner will (TLW) conduct a scientific experiment to explore the topic of disease transmission.
b) TLW practice using lab skills and working in a group.

Materials:

For each student: a copy of the lab procedure (typed up by one of the students and photocopied for the class); paper towels with which to dry their hands. Also, you will likely need 5 or more LB nutrient petri dishes for each student, as well as hand soap, paper towels; a permanent marker, scissors, and Parafilm for each lab group; and any other supplies as determined by the procedure selected during the previous class.

Procedure:

1. One hour prior to class, take the LB plates out of the refrigerator and place them upside down on the supply table so they can warm to room temperature. You may want to arrange the plates in stacks, so the students can pick them up with a minimum of confusion and handling mishaps. It is very important that the plates not be opened except during the brief moment when they are being inoculated for the experiment (in this case the "inoculation" will probably be when the student presses or rubs their hand against the nutrient agar to transfer any existing bacteria or fungi to the growth medium). If you are concerned whether your students will be able to follow this rule, do not allow them to take the plates to their desks until the moment they will be used. Place enough Parafilm strips and scissors on the supply table so that each lab group will be able to reseal their petri dishes immediately after use. If there are any additional supplies, such as

hand soap, hand gel, or paper towels, these should also be set on the supply table so lab groups can pick them up as they enter.
2. When class begins ask the students to help you create a data chart on the board that would be most appropriate for this lab experiment. Have the students edit one another's ideas until they arrive at a data chart that is mutually agreed upon. Ask the students to copy the data chart in their notes.
3. Before conducting the experiment, discuss the rules that must be followed when working with nutrient plates: Do not open a plate unless you are inoculating it, reseal all inoculated plates, and do not open a plate after it has been inoculated.
4. Ask the students to label their petri dishes with the permanent marker before they begin and discuss with their lab group how they will proceed.
5. Allow the students to follow the printed version of the procedure that was approved in the previous class period.
6. Be sure to monitor the sealing of the inoculated petri dishes with Parafilm. Inoculated plates should not be opened by students for any reason, due to the risk of infection after organismal growth has begun.
7. After all the nutrient plates have been inoculated and sealed, ask the students to move the plates into an incubator or a warm, moist area out of direct sunlight so the bacteria and yeast have ample opportunity to grow.

IV. Activity Two: Nonspecific Immune Response — 15 minutes

Objectives:

a) TLW explore the active ways the human immune system responds to potential pathogens.
b) TLW understand what makes a body part vulnerable and the various means of defense available.

Materials:

For the class: one large knitting needle; one salt shaker; one bottle of acid (it will be used as a prop, so you could substitute an empty brown bottle with a large label that says "ACID"); one hair dryer; one toy shield; one end segment of a garden hose; one bouquet of flowers; one glue trap (for catching rats); one piece of shag rug or a thick bristled brush. For each student: one nametag/shirt sticker; one copy of the "First Line of Defense" handout and the "Lab Report Requirements" handout, both of which follow this lesson plan.

Procedure:

1. Prior to class, place all of the items (props) listed in the materials list on a table in the middle of the room.
2. To begin the activity, divide the students into two groups: pathogens and vulnerable body parts.

3. Ask the students in the "vulnerable body parts group" to each represent a body part that is vulnerable to the immediate environment. Allow them time to think of which parts they could be, while you give instructions to the pathogens group. Some body parts that are vulnerable to pathogens include: skin, ears, mouth, eyes, nose, stomach, lungs, urethra, mammary ducts, vagina, and anus (tell the students you will excuse them from representing the mammary ducts, vagina, urethra and anus for the sake of helping them stay focused). Each of the first seven body parts on the above list should be represented. If the class is large, multiple students can represent the same body part; if the class is small, one or more students can each represent multiple body parts. Have the students each place a sticker on their shirt that states the body part they represent.
4. Ask the students in the "pathogens group" to each choose a specific pathogen they will represent. If your students are not able to name specific pathogens, ask them to refer to their textbook, Internet or peers to come up with a specific pathogen for each person in their group (for example, "Streptococcus" or the "rabies virus", not just "bacterium" or "virus"). In addition, the members of this group must ensure that there is at least one pathogen to attack each of the following parts of the body: skin, ears, mouth, eyes, nose, stomach, and lungs. Also, they must represent a variety of living and nonliving pathogens. Living pathogens might include bacteria, viruses, parasites, and pollen, while nonliving pathogens might include items such as dander, a glass shard, or a splinter. Give the group a few minutes to organize themselves. Once they have decided on the specific pathogens they'll represent, have each student place a sticker on their shirt that states the pathogen they represent.
5. Explain to the students in the vulnerable body parts group what each of the props on the front table represents: the knitting needle—lysozymes or other enzymes that burst cells; salt shaker—salt, which causes lysis or deters cell growth); bottle of acid—low pH, which kills cells or deters cell growth; hair dryer—dryness, which desiccates cells or deters cell growth; toy shield—impervious layer of tightly bound cells or a sphincter with limited entry; end of garden hose—the flow of mucus, urine, sweat, tears, and other fluids or expelling force, such as a cough or sneeze, that pushes pathogens out of the vulnerable area; bouquet of flowers—"good" bacteria that live on the body and maintain the natural environment or help with the processes of that part of the body; sticky glue traps—mucus membranes; and a brush or piece of shag rug—ear or nose hairs or the cilia of the mucus membranes.
6. Ask the students in the vulnerable body parts group to determine which defenses each of the body parts exhibits, from the categories listed in step 5 above (the *Teacher's Version* of the "First Line of Defense" handout has a detailed description of the defenses for each body part). For example, the group should decide if the skin has all of the various types of protective defenses or just some of them. Give the group a few minutes to organize themselves; they may use their textbook, the Internet, or guidance from peers to make their decisions.
7. When both groups are ready, direct the students as follows:

a. Ask the first pathogen to step forward and state their name (for example, H1N1 virus, urushiol from poison ivy, E. coli, etc.) and list the part(s) of the body they would be likely to attack.
b. The part(s) of the body being attacked should then step forward.
c. The pathogen will now pretend to attack the body part(s), and the body part(s) will use the defense mechanisms (items from the props table) that it would normally use to defend itself, while narrating what it's doing. For example, the nose might say, "Mucus [while holding up the sticky rat traps] is used to trap foreign particles; cilia [while gesturing with the rug scrap] will sweep the foreign particles to the pharynx for swallowing or will expel the pathogen with a sneeze [while holding up the hose to represent an expelling force]; and salt [while holding up the salt shaker] in the mucus will kill the pathogen by desiccation [while brandishing the hair dryer]; local flora [while holding the bouquet] defend the nose tissues by taking up space and not allowing the pathogen to find an adequate host tissue on which (or in which) to reproduce."
d. You may help guide the students who go first, but use questions to guide them, so that they begin to take over or look for guidance from their peers.

8. After all the pathogens have attacked each of the body parts, distribute the "First Line of Defense" handout and ask the students to complete the chart, to reinforce their understanding of the concepts.

HW: Ask the students to read the journal article on hand washing among health care workers (HCW) that is cited below. Like most peer-reviewed scientific publications, this article follows the same format as a lab report, so besides giving the students additional information about the topic they are studying, it will help them understand what type of information is included in the Introduction section of a lab report. After the students have read the article, ask them to list the topics the author has included in her Introduction section. Next to each topic listed, they must explain why this particular topic was discussed in the Introduction section of the lab report/article. Ask the students to also answer the following question, based on what they've read: "If you were a governing officer of a hospital, what recommendations would you make regarding hand washing? Cite data from the article to support your recommendations." If you feel this article is too long for your students, cut and paste the critical portions of the article that you would like for your students to read, focusing on the topics included in the Introduction section and that pertain to the above discussion question ("If you were a governing officer of a hospital…").

Journal: Clinical Infectious Disease, 2000 University Chicago Press
http://www.journals.uchicago.edu/doi/pdf/10.1086/313888

Special Section: Health Care Epidemiology - A. Weinstein, Section Editor

Replace Hand Washing with Use of a Waterless Alcohol Hand Rub? Andreas F. Widmer, Division of Hospital Epidemiology, University Hospitals, Basel, Switzerland, pg. 136-143 CID 2000:31 (July).

HW: Distribute the “Lab Report Requirements” handout and ask the students to each write an outline for the Introduction section of their immune system lab experiment, using the handout to identify the elements that should be included in this section.

The First Line of Defense

Nonspecific Immune Response

Check off the types of protection that defend each part of the body:

Vulnerable Body Part	Dry surface	Sticky, wet, waxy mucus	Low pH	Hair or cilia	Salt	Expelling force or liquid flow	Defensive local flora	Lysozymes or lytic secretions	Physical barrier(s), sphincters
Skin									
Ears									
Mouth									
Eyes									
Nose									
Stomach									
Lungs									
Mammary ducts									
Urethra									
Vagina									
Anus									

The First Line of Defense

Teacher's Version

Nonspecific Immune Response

Check off the types of protection that defend each part of the body:

Vulnerable Body Part	Dry surface	Sticky, wet, waxy mucus	Low pH	Hair or cilia	Salt	Expelling force or liquid flow	Defensive local flora	Lysozymes or lytic secretions	Physical barrier(s), sphincters
Skin	√		pH 3-5	√	√	Oil, sweat	√	√	√
Ears	√	√	Low pH	√		Wax	√	√	
Mouth		√		√		Saliva	√	√	
Eyes		√			√	Tears	√	√	√
Nose		√		√	√	Sneeze	√	√	√
Stomach		√	pH 2			Acid	√	√	
Lungs		√		√	√	Cough	√	√	√
Mammary glands						Breast milk	√	√	√
Urethra		√	Low pH			Urine	√	?	√
Vagina		√	Low pH			Vaginal fluid	√	?	
Anus		√				Feces	√	?	√

Lab Report Requirements

All laboratory reports should be typed, neat and legible, with correct spelling, punctuation, and grammar usage. All pages of the report should be on 8.5x11-inch paper in black ink (do not use markers, color printers, or color graphs).

Title

- The title should describe the topic studied in one complete and extremely detailed sentence that includes the subject, location, and duration of the study.

Introduction

- Background information for all topics that will be discussed should be defined and described in detail, including an explanation about why the topics are useful for this study (written in the present tense).
- Clearly state the purpose (there may be more than one) of performing this lab (written in the future tense).
- Explain exactly how you intend to achieve the purpose(s) described (written in the future tense).
- Give a clearly stated hypothesis that tells what you think will be the answer to the question you are studying (written in the future tense).

Methods

- List all of the equipment needed to conduct this experiment.
- Describe in paragraph form, using complete sentences, how the procedures of this experiment can be repeated (written in the present tense).
- Do not include any unnecessary information.

Results

- Include a data chart that contains the data collected and that is neat and clearly structured.
- Include an appropriately labeled and titled graph for all data collected, separating information into individual graphs as needed.
- Include a paragraph describing all major trends or lack of trends, averages, and directly or inversely correlated data (written in the past tense).

Conclusion

- State any conclusions that can be drawn from the data you collected (written in the past tense).
- Revisit your purpose and your hypothesis, comparing what you thought before you gathered your data to what you found after you analyzed your data (written in the past tense).
- Report any potential errors, avoiding exaggeration, overstatement, or minimization of errors (written in the past tense).
- Explain other experiments that might be performed to supplement the conclusions of this experiment (written in the future tense); where does your data lead you next?

Experimental Biology Curriculum
Anatomy and Physiology Unit

Day 3

I. Topic: Immune System

II. Warm-up: **5 minutes**

Prior to class, write the following on the board: "First, check on nutrient plates. Make observations in your lab notebook and return the plates to the incubator for continued growth. Next, draw a picture of cells on your body that are exposed to the outside environment (such as skin cells, cells in your lungs, or in your mouth, etc.) and include in the picture the cellular structural defenses you imagine they must have to protect themselves against pathogens, based on the simulation we performed in the last class. Think about how the defenses we simulated might look at the cellular level—for instance, how can a group of cells sweep pathogens away from their surfaces?"

III. Activity One: Vulnerable Epithelial Tissues **35 minutes**

Objectives:

a) The learner will (TLW) examine samples of epithelial tissue to see how the structure of these cells suits the function they serve in an organism.
b) TLW compare the similarities and differences of various types of epithelial cells.

Materials:

For each student (or pair of students): one compound microscope; one slide of an example of epithelial tissue (it is important to have a diverse set of tissue samples, such as: different skin cross sections; lining of multiple regions of the gastrointestinal tract; lining of bladder; lung/bronchial tissue, etc.); one copy of the "Tissues - Part I" handout which follows this lesson plan.

Special Note: There are very high-quality images that can be found easily on the Internet and projected in the classroom, if you do not have access to the number of slides or microscopes needed to outfit each of your students. You may also choose to use projected images for parts of this activity in order to point out certain structures to the entire class.

Procedure:

1. Prior to class, draw an outline of a human figure on the board and label the major organs represented by the slides of tissue samples you have chosen (ex: lungs, GI tract organs, bladder, etc.). Next to your drawing write the title of each slide that will be used in class today, and then draw an arrow to indicate the location where this sample tissue was taken from the body. For example, if the slide is titled "Mammal Duodenum," you would draw an arrow to the first section of the small intestine to let the students know that this tissue was removed from the internal lining of the small intestine. For students who do not know the terms used for various parts of the body, the slide titles sometimes add an additional layer of mystery that inhibits them from understanding the main concepts. Each time you use samples or slides, try to make clear any unfamiliar terms; the students will learn the vocabulary when they are ready for more information.
2. When the students are settled, begin the class by going over the warm-up:
    a. What types of protection do cells and tissues have to ward off pathogens? *(Hairs, cilia, mucus, waxes, oils, salts, low pH, lysozymes, local flora, dryness.)*
    b. What evidence of these protective defenses would we see if we were to examine a cell up close? *(Glands, hair follicles, vesicles of secretions moving to the cell membrane, numerous lysosomes, cilia, cells bound to one another tightly, layers of dead cells on top of live tissue, etc.)* Some students may want to share their drawings with the rest of the class if they have completed this part of the warm-up.
    c. Which cells in the body are most likely to display these first-line-of-defense features? *(Cells that come into contact with the outside environment. Called epithelial tissues, these are the cells that make up our skin and line our respiratory, digestive and excretory tracts.)*
3. Ask the students (or pair of students) to each set up their compound microscope and place their slide on the stage with the power adjusted to the lowest setting. If you have not reviewed the handling and parts of a microscope, you will probably want to do so at this point.
4. Ask the students to examine their sample while changing the light, to decide which light setting is best.
5. After they have focused and observed the sample on low power, ask the students to move up to medium power, and again change the light setting to find the best visual effect.
6. After they have focused and observed the sample on medium power, ask the students to move up to high power, and again change the light setting to find the best visual effect.
7. Ask the students to decide which magnification and light setting were the overall best for this particular slide. Ask them to tell you if they see any evidence of structures on the cells that might be helping the organism defend itself against pathogens.
8. Distribute the "Tissues - Part I" handout and ask the students to read the instructions. Clarify any questions and tell the students they will be looking at

several different slides today without changing their microscope setting significantly, so that they can look at as many sample slides as possible during this activity.

9. Allow the students time to add any information to their handout, based on the slide they set up, and then ask the students to leave their slide in place and rotate to the next microscope.
10. Give the students a few minutes at each microscope, having them rotate around the room until all have had a chance to see every tissue sample.

IV. Activity Two: What's in an Introduction? 10 minutes

Objectives:

a) TLW compare the Introduction topics they think are relevant to the topics their peers think are relevant.
b) TLW back up their ideas with reasoning and include or eliminate topics in their Introduction outline as deemed necessary.

Materials:

Each student will need their Introduction section outline completed for last night's homework, and their copy of the "Lab Report Requirements" handout (from Day 2 of this unit).

Procedure:

1. Ask the students to show you their Introduction outline for the immune system lab experiment. If any student has not completed their outline, ask them to sit alone and finish their work (without getting credit for this assignment).
2. Ask the class to divide into lab groups and compare their outlines to make a composite outline for their group. Tell them they must include all the necessary background information in their lab to get full credit; their Introduction must be thorough. They should also consult the "Lab Report Requirements" handout to make sure they have all the necessary components in their outline.
3. After the students have decided on the items that should be included, they can use any remaining time to talk about details that might be discussed under each main topic.

HW: Ask the students to each write the complete Introduction section of their lab report.

Tissues - Part I

Epithelial Tissues

Move around the room looking at each sample slide of epithelial tissue. The samples will reveal evidence of traits that help defend the body against pathogens. When you find an example of cells that secrete oils, salts, mucus, or acids—or if you observe cells that are shielded by hairs or cilia, or cells that are tightly bound to neighboring cells in order to shield interior tissues—do the following:

1. Write the title of the slide in the empty box to the right of the structure (hair, cilia, etc.) listed in the second column, below.
2. In the same space, draw a diagram of the protective structure(s).
3. If you need a description of the items listed in the chart, follow the asterisks to the descriptions below the chart.

Evidence of the First Line of Defense in Epithelial Cells

Physical shields:				
	Hair			
	Cilia*			
	Cell junctions **			
Secretions:				
	Mucus, oil, or sweat glands			

*Cilia are short hairs made of protein that help sweep pathogens over the surface of a cell.
**Cells can be tightly bound together by cellular junctions to make a strong, flexible sheet that is impenetrable to pathogens. There are three types of cellular junctions you can look for:

(1) tight junctions in which proteins on the cell membrane intertwine and pinch two cells together;
(2) anchoring junctions (aka desmosomes) in which cells are fastened together by keratin proteins bound to internal intermediate filaments;
(3) gap junctions in which cytoplasm can move freely between neighboring cells through protein channels.

Experimental Biology Curriculum
Anatomy and Physiology Unit

Day 4

I. Topic: Specific Immune Response

II. Warm-up: 5 minutes

Prior to class, write the following on the board: "Check on your nutrient plates. Make observations in your lab notebook and return the plates to the incubator for continued growth. When you're finished, find a partner who is also finished and describe all the ways your immune system reacts to a mild injury—such as falling and scraping your knee—from the moment the injury occurs until about 10 days later."

III. Activity One: Second Line of Defense/Inflammatory Response 30 minutes

Objectives:

a) The learner will (TLW) discover that the second line of nonspecific immunological defense relies on cell-signaling proteins and phagocytic cells.
b) TLW identify the cascade of events that occurs when a pathogen invades tissues of an organism.

Materials:

For each student: one pair of scissors; one copy of the "Nonspecific Immune Response - Second Line of Defense - The Inflammatory Response" and "Second Line of Defense Inflammatory Response Flow Chart" handouts, both of which follow this lesson plan; tape or glue; one nametag/shirt sticker.

Procedure:

1. Distribute the two handouts and the lab supplies.
2. The following activity does not require explanation or a lecture; there are enough clues that students will be able to deduce the relationships by reading and thinking about what they already know. Tell the students they may use their textbook or consult with a partner only after they have made their own best guess of how the processes are related. Remember that any time you do the thinking for your students you are depriving them of the opportunity to think for themselves. In addition, students tend to learn on a "need to know" basis—they will ask for additional information as they need it. So, being receptive to questions and thinking of questions you can pose yourself, to induce curiosity

and engagement, will be more beneficial during this stage than telling the students everything up front.

3. Ask the students to cut out the descriptions and illustrations from the "Nonspecific Immune Response - Second Line of Defense Inflammatory Response" handout.
4. Ask the students to arrange the descriptions and illustrations on the flow chart so that the events of the inflammatory response are mapped in the correct sequence.
5. Ask groups of 4-6 students each to act out the process of the inflammatory response in a short skit, with each person wearing a nametag sticker that states their role in their skit. Or, to make these skits more thought-provoking for the audience, ask each group to perform their skit *without* nametags, and then ask the audience to try to identify the role each student played.

IV. Activity Two: Diverse Connective Tissue 15 minutes

Objectives:

a) TLW observe and identify different types of connective tissue cells on prepared slides.
b) TLW discover how the size and location of a cell relates to its function.

Materials:

For each student (or each pair of students): one compound microscope; one prepared slide of human blood (commercially prepared slides only; it is illegal to use real human blood in the classroom); one prepared slide of each of the following (or you may use digital images, if slides are not obtainable): spongy bone, red blood cells, white blood cells, platelets, bone marrow stem cells, and osteoblasts; one copy of the "Tissues - Part II" handout which follows this lesson plan.

Procedure:

1. Distribute the "Tissues - Part II" handout and allow time for each student to view the tissue slides they have been given and take notes.
2. You may want to take a few minutes to share digital images of SEM photos of blood components and the bone cells from which they arise.

HW: Ask the students to read their textbook and create a mind map for specific immune response (aka the third line of defense, or antibody and cell-mediated response) similar to the flow chart they created today during class.

Nonspecific Immune Response

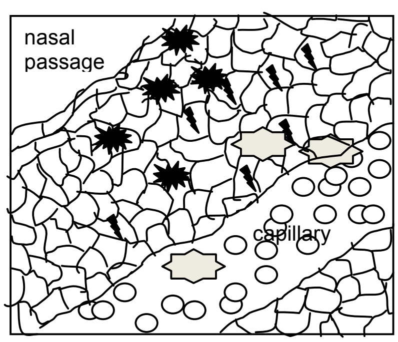
Second Line of Defense - The Inflammatory Response

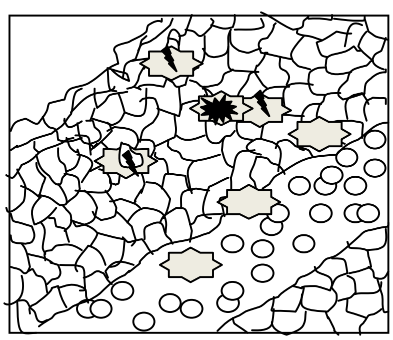
Cut out each text and diagram box below; then place each item in the appropriate spot on the flow chart that follows.

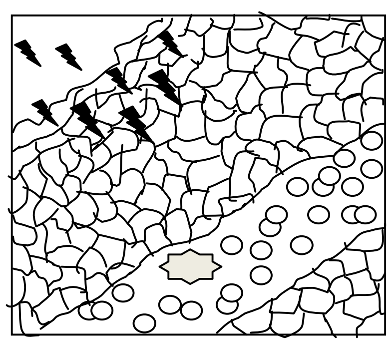
Macrophage, monocytes and neutrophils (aka WBCs) consume free pathogens	Platelets arrive at site of injury and begin to bind with protein fibers to make a clot or scab	Natural killer cells consume body cells that have been invaded by viruses
Cells nearby shut down protein synthesis to inhibit the growth of viral pathogens	Monocyte, macrophage, neutrophil and natural killer cells (aka WBCs) follow the protein signals to the site of the injury	Histamine and prostaglandins are released by injured cells and WBCs
Interferon is released by cells infected with viral pathogens	The temperature of the body rises to inhibit the growth of bacteria or viruses	
Capillaries dilate so platelets and WBCs can move from the bloodstream to the site of the injury	Chemokine proteins are released by the injured cells to set up a path that directs WBCs and platelets to the site of the injury	Pyrogens are released by WBCs and as a reaction to proteins released by some pathogens

white blood cells   red blood cell   epithelial cells   virus particle

damaged epithelial cells







Second Line of Defense
Inflammatory Response Flow Chart

Diagram | Cell Signal Proteins | Phagocytic White Blood Cells

Step 1

Virus particles invade the throat tissue; epithelial cells in the throat are vulnerable to invasion by the virus; nearby capillaries contain red and white blood cells, platelets and other blood proteins.

Step 2

Step

Tissues - Part II

Connective Tissue

1. After examining a slide tissue sample, draw the three major components of blood in the correct relative sizes and abundance.

2. Explain why each blood component is the particular shape and size that it is, based on the function this type of cell serves in the body.

3. Explain how cells of the immune system communicate with one another. What type of macromolecule is involved? How does one cell send out information to another cell? How does a cell receive information from another cell?

4. White blood cells, red blood cells, and platelets are three types of connective tissue. What other types of cells are made of connective tissue?

5. Blood cells are manufactured in the marrow of certain bones. Bones are also a type of connective tissue. Draw and label osteoblast cells—the bone cells that release collagen fibers and minerals that harden into bones.

Experimental Biology Curriculum
Anatomy and Physiology Unit

Day 5

I. Topic: Vaccinations, Allergies and Related Issues

II. Warm-up: 5 minutes

Prior to class, write the following on the board: "Check on your nutrient plates. Make observations in your lab notebook and return the plates to the incubator for continued growth. Then pick up a copy of the "Graphing Scientific Data" handout and create a graph for Data Set A."

Special Note: If you have already performed the following activity (creating good scientific graphs) in another unit from Catalyst Learning Curricula, then you may want to instead guide the students through a deeper concept related to the immune system, such as: how vaccinations boost immunological resistance, how the human body reacts to allergens, the biology of the AIDS virus or another immunological disorder, such as Lupus or rheumatoid arthritis, etc.

III. Activity Two: Creating Scientific Graphs 30 minutes

Objectives:

a) TLW analyze the attributes of a good scientific graph.
b) TLW correct their own graphing techniques and incorporate new methods.

Materials:

For each student: one copy each of the "Guidelines for Creating Scientific Graphs" handout and the "Graphing Scientific Data" handout, both of which follow this lesson plan; graph paper; a ruler.

Procedure:

1. Ask the students to divide into pairs and compare the graphs they made for the warm-up.
2. Ask the student pairs to identify the best aspects of their two graphs and discuss how each graph could be improved.
3. Distribute the "Guidelines for Creating Scientific Graphs" handout and go over each item, giving examples when necessary. Some students may feel comfortable showing their own graphs as good or poor examples of particular qualities.

4. Allow the students to work in pairs and practice graphing Data Sets B and C, using the “Guidelines for Creating Scientific Graphs” handout as a reference.
5. Ask the student pairs to critique their work, sign both their names to their “Graphing Scientific Data” handouts and turn them in for grading.

IV. Activity Two: Lab Results 15 minutes

Objectives:

a) TLW explore different ways to represent collected data in a visual format.
b) TLW determine the parts of a graph that must be included in a final draft.

Materials:

Each student will need the data collected from their immune system lab experiment.

Procedure:

1. Ask the students to divide into lab groups and create a graph or graphs of the data they gathered for the immune system lab experiment.
2. Remind the students that all graphs will be graded for the quality and accuracy of five components:
    a. A title that includes the two items that were compared and any other relevant information, such as location or duration of the experiment;
    b. Independent and dependent axes labeled with units;
    c. Even increments on each axis and good use of the graphing area (not small and squashed, not bursting off the page);
    d. Neatness and clarity (use of graph paper and a straightedge are required);
    e. Appropriateness of the graph chosen: the graph should tell the viewer, in a single glance, what the experiment was about and what happened (a picture is worth a thousand words).
3. Ask each group to identify trends and conclusions, based on their data.
4. Tell the students they will be expected to finish writing the Results and Conclusion sections of their lab report for homework, so now is a good time for them to clarify any ideas or get help from their peers, as needed.

HW: Ask the students to finish writing the Results and Conclusion sections of their lab report, making sure each meets the criteria on the “Lab Report Requirements” handout.

Guidelines for Creating Scientific Graphs

Please adhere to the following rules when you are creating a graph:

1. A graph is a picture worth a thousand words. Be sure that your graph is a visual summary of your data, conveying what happened in the experiment.
2. All graphs must be on graph paper and drawn with a straightedge or ruler. Graphs can also be computer generated, if you are able to execute all of the items on this list on your computer.
3. All graphs must have a scientific title that includes the topic, the organism of study, the time period, the variable, and all other relevant data. A scientific graph title is often a sentence that begins with a capital letter and ends with a period.
4. Use the appropriate type of graph for your data. Pie graphs are only to be used with categorical data that represent a portion of 100%.
5. Your independent variable must go on the x-axis (time is often the independent variable).
6. Your dependent variable must go on the y-axis.
7. Each axis must be clearly labeled with the topic and the units.
8. Each axis must have evenly spaced increments.
9. Each axis must exceed the range of the data.
10. All symbols must be clearly defined.
11. All graphs must include a figure caption.
12. All graphs must be discussed in written form in your results section.
13. Do not use 3-D graphs unless your data contains a third dimension.
14. Do not use sharply contrasting patterns or colors (it can make one data set look larger or smaller than it actually is and create bias).
15. Use the entire space of the graph to represent your data (do not put a few lines in the bottom corner of a large sheet of graph paper).
16. Do not allow your data to project to the top or side limits of your graph (it gives the impression that the data exceeds the limits of the graph).
17. Do not connect the dots of data points that do not represent the same individual or the same study group.
18. Ask your teacher if you may use color in your graphs.

Additional resources on creating scientific graphs:

Pechenik, Jan, *A Short Guide to Writing About Biology*, Harper Collins College Publishers, pp. 63-83, 1993.

AP Biology Lab Manual for Students, College Entrance Examination Board, pp. 147-161, 2001.

Graphing Scientific Data

Please graph the following data by hand, using graph paper and a straightedge. If the data would be best represented by a pie graph, please use a protractor or trace the base of a cylinder to draw the graph.

Data Set A: Number of reported cases of Pertussis (Whooping Cough) in the U.S. and Brazil from 1980 to 2008

Year	United States (population ~300,000)	Brazil (population ~200,000)
2008	13,213	1275
2007	10,454	596
2006	15,632	797
2005	25,616	1328
2000	7867	764
1990	4570	15,329
1980	1730	45,752

http://www.who.int/

Data Set B: Percentage of deaths by preventable diseases worldwide for children under 5 years in 2002.

Preventable disease	Percentage of the 1.4 million preventable deaths
Measles	33%
Hib	27%
Pertussis	20%
Neonatal tetanus	13%
Tetanus	1%
Polio, diphtheria, yellow fever	1%

http://www.who.int/

Data Set C: Annual deaths due to tobacco use estimated worldwide, 1950-2030.

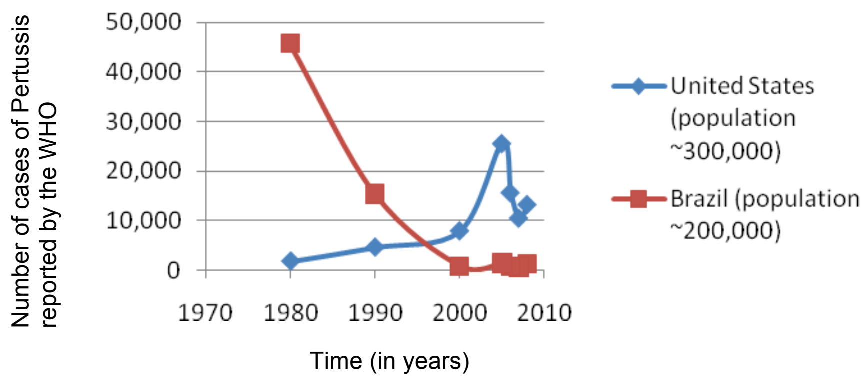
Date	Developed Countries	Undeveloped Countries
1950	0.3 million	~0
1975	1.3 million	0.2 million
2000	2.1 million	2.1 million
2030	3 million	7 million

http://www.who.int/

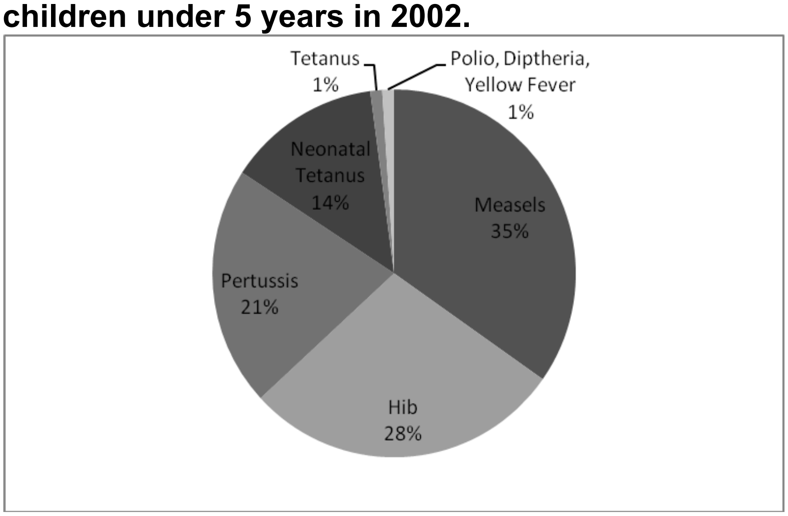
Graphing Scientific Data

Teacher's Version

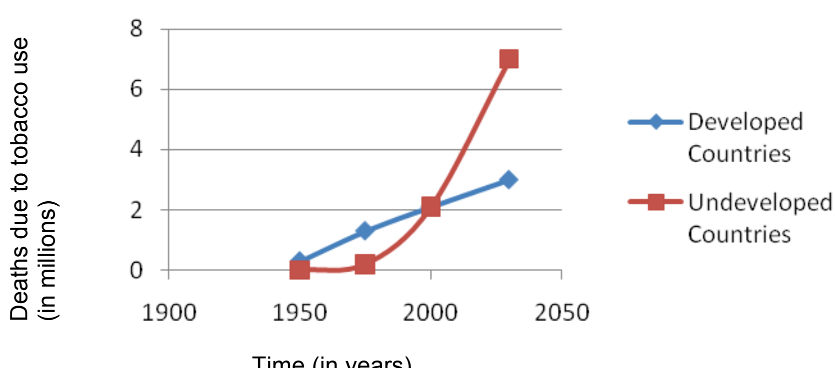
Data Set A: Number of reported cases of Pertussis (Whooping Cough) in the U.S. and Brazil from 1980 to 2008. *(This graph could also be a column graph or scatterplot.)*



Data Set B: Percentage of deaths by preventable diseases worldwide for children under 5 years in 2002.



Data Set C: Annual deaths due to tobacco use estimated worldwide, 1950-2030. *(This graph could also be a column graph or scatter plot.)*



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