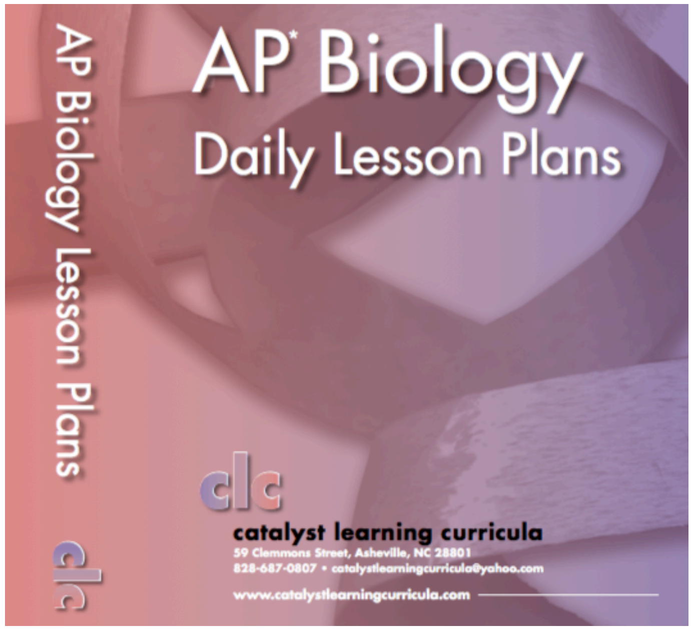

AP® Biology
Daily Lesson Plans
(samples)

This full-year curriculum includes:

- 142 sequential lesson plans covering the entire College Board curriculum including laboratory skills and test preparation
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AP® Biology
Daily Lesson Plans Curriculum
Table of Contents
(with three sample lesson plans to follow)

AP® Biology Daily Lesson Plans
Cell Biology Unit
(A sample lesson plan)

Day 9 – Extended Class Period

I. Topic: Membrane Transport

II. Warm-up: 5 minutes

Assign the students to groups of 2 to 3 people and distribute the team challenge instructions.

III. Activity One: Diffusion and Osmosis Team Challenge 85 minutes

Objectives:

a) The learner will (TLW) review and integrate the concepts of diffusion and osmosis.
b) TLW collaborate and function with a group in a self-directed manner to answer a scientific question.

Materials:

Students will need the sucrose solutions prepared on Day 12 of the Biochemistry unit. Beakers, cups, stir rods, mass balances, hot plates, water-based food coloring and all of the other supplies that were available to the students in the last two days of class.

Procedure:

1. Prior to class, change the labels on the sucrose solutions to A, B, C, D and E so that there is no indication of the molarity. Mix up the order of the solutions before labeling them so that the labels do not indicate the concentration of the solutions. Be sure to write down in a secret place the name that is used for each solution, so that you know which molarity corresponds with each letter. Add the same number of drops of water-based food coloring to each container so that each solution has a different and easy to recognize hue (do not make the colors any deeper than necessary, because the dyes may impact the rate of diffusion through the dialysis tubing if they have an additive that adheres to the tubing pores). Keep the sucrose solutions in the refrigerator or in an ice bucket so the sucrose is completely dissolved but the solutions are cold (this will impair the rate of diffusion for any lab group that does not heat the solutions). Based on the number of teams that will be sharing the solutions, determine the maximum amount of each solution that can be used by any one team (for example, if you have 1 liter of each of 1.0 M, 0.8 M, 0.6 M, 0.4 M and 0.2 M solutions of sucrose and ten teams, then each team can use up to

100 ml of each solution, max). Only ~20ml will fit into a 16 cm section of dialysis tubing so all teams should have the ability to answer each challenge if they have access to ~25 ml of each sucrose solution.

2. Prior to class, obtain enough equipment so that teams do not have to wait long to use common materials and have enough beakers or cups to make comparisons for reactions conducted at the same time. Make available enough spools of dialysis tubing as well as enough rulers and scissors such that the students can access these supplies quickly, as needed.
3. Pass out the team challenge questions. Both questions can be answered using only one well-designed experiment, however many lab groups will address each question separately, taking up the time needed for the challenge and putting them at a distinct disadvantage. Do not give the students any help or any hints. Take note of the communication, cooperation and teamwork aspects of their progress. Note the level of creativity and flexibility each team uses to address the challenge.
4. Let the students know they are receiving a grade for their ability to function as a lab group and that safety as well as cooperation with the wider class are components of their grade. Penalize any team that monopolizes supplies or does not use appropriate lab techniques (mixing solutions or pipettes, mishandling glassware or hot items, not using goggles, taking shared supplies from common areas, etc.)
5. Ask the teams to each submit a mini-lab write-up of their procedure, a diagram or photos of their experimental set-up, a chart of their collected data and the conclusions they made based on their results. Each team should include self-reflection notes on their group, mentioning the strengths and weaknesses of their communication, group function, direction of scientific exploration and laboratory techniques. All teams must also clearly state the order of the solutions from lowest to highest concentration and all teams must submit evidence (photo or video) of their maximum change in mass. The mini-lab write-up can be in the form of a submitted paper or shared digital document.

HW: Complete the Diffusion Team Challenge mini-lab write-up and prepare for the first test on Cell Biology Unit topics.

Diffusion and Osmosis Team Challenge

Your two goals are to:

- Correctly rank the solutions A, B, C, D and E in order from lowest to highest concentration.
- Achieve the largest change in mass for a single 16 cm segment of dialysis tubing (photo documentation required).

Guidelines for achieving this goal:

1. You may use up to six cups or beakers; six 16 cm strips of dialysis tubing and up to 100 ml of each solution (this amount may be modified by your teacher at the start of the competition).
2. You may use any techniques that would allow you to achieve the above stated goals as long as they are safe and fair.
3. Each team member must document the procedure in their lab notebook in both written and visual form (photos, diagrams, etc.) to validate the change in mass observed.
4. You may use other equipment in the lab as desired as long as you are considerate to others. You will be penalized if you use more supplies then are allotted to your group or you may be disqualified if your use of materials is excessive and cuts short the other groups' allocated time with the materials.
5. The first part of your grade will reflect the functionality of your team in terms of communication, collaboration, respect and focused self-direction.
6. The second part of your grade will be based on your team results. Photo documentation of your results must be submitted to me using Google Classroom within 12 hours of completion of the competition and included in a mini-lab write-up—only one write-up per team, please. All team members must contribute equally to complete the following in your write-up:
   a. Describe the procedure(s) your team used
   b. Explain why this/these procedures were chosen
   c. Report observations and data collected in a chart
   d. Analyze data appropriately
   e. Draw conclusions and state:
      i. the order of the solutions in terms of lowest to highest concentration
      ii. the maximum change in mass for any one 16 cm length of dialysis tubing
   f. Reflect on the functionality of your group dynamics, collaboration, communication and decision-making, using examples
   g. Reflect on the procedure(s) used, impact of errors, and improvements that you would make

The winners from each class will receive recognition and a prize.
Strut your scientific method!

AP® Biology Daily Lesson Plans
Genetics Unit

(A sample lesson plan)

Day 14

I. Topic: Prokaryotic Genomes

II. Warm-up: 5 minutes

Prior to class, write the following on the board: "Check your bacterial plates for results. (While students obtain their lab results, walk around the room questioning students individually to verify their understanding.)"

III. Activity One: Prokaryotic Operons 40 minutes

Objectives:

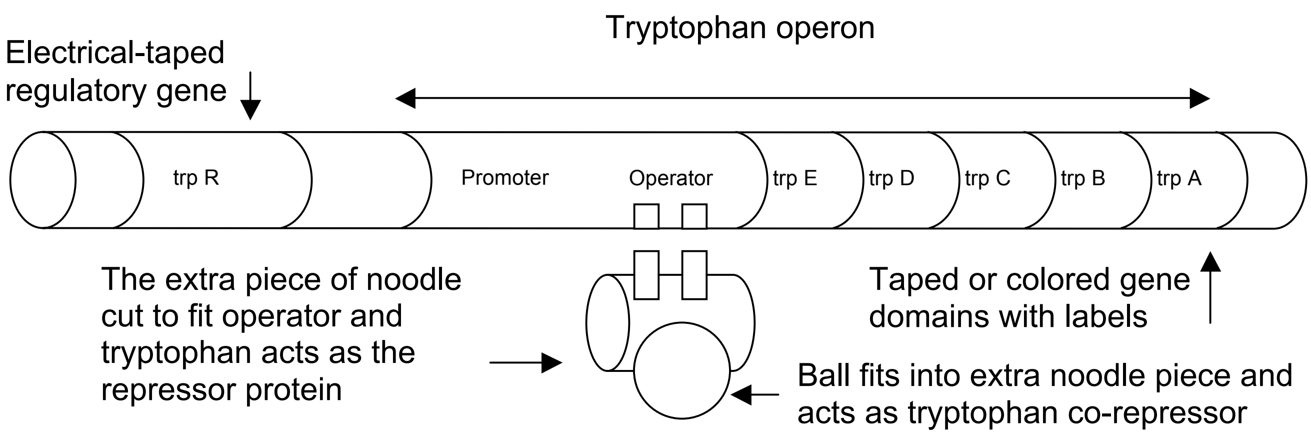
a) The learner will improve (TLW) their understanding of gene regulation by making models of inducible and repressible operons.
b) TLW realize the usefulness of models in explaining scientific phenomena and processes.

Materials:

Each lab group will need: 2 foam pool "noodles" in different colors; 7 different colors of electrical tape or 7 different colors of Sharpie markers; 1 wire coat hanger; wire cutters; 2 racquet/tennis balls; 6 stick-on Velcro tabs.

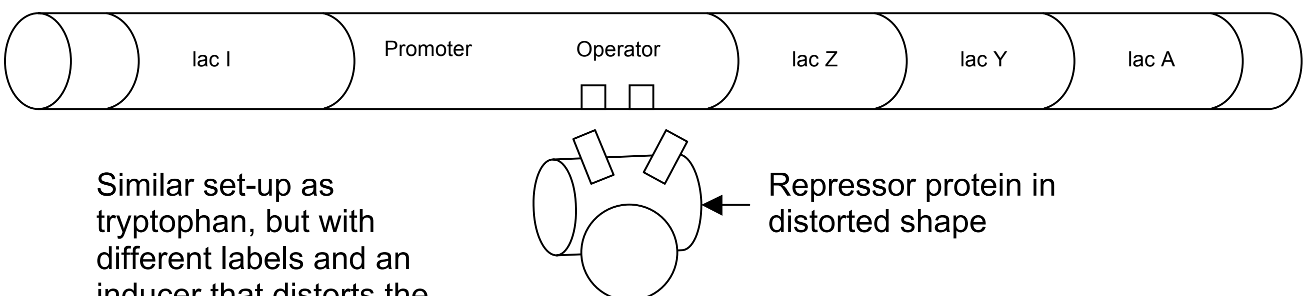
Procedure:

1. Lead the lab groups through the process of making a model of a repressible operon using the above supplies and the following sample diagrams of a prokaryotic tryptophan operon. For the repressible operon, use the prokaryotic tryptophan operon as an example:



a. Using a serrated knife, cut an 8-inch segment from the first noodle (steps 1a-i will apply to this noodle). This segment will be used as the repressor protein.
b. Each end of the noodle/operon should feature an unlabeled/ untapped section to show the continuation of the DNA strand.
c. Wrap spirals of colored electrical tape (or shade the noodle with colored Sharpies) where each of the five gene domain regions would be found (trpE – trpD – trpC – trpB – trpA), using a different color for each gene domain.
d. Tape or shade in the regulatory gene (trpR) region as far upstream of the promoter region as possible.
e. Using a Sharpie, draw the shape of the active form of the repressor protein onto the lower portion of the noodle/operon, in the operator region. Make the shape simple, like the one in the diagram, since you will need to carve it out using a serrated knife. Also, carve a matching shape into the regulatory repressor protein piece that you cut off in step "1a" above.
f. On the bottom side of the repressor protein, carve a "U" and wedge the racquet/tennis ball into the "U".
g. Cut a piece of wire from a coat hanger and shove the wire into the repressor protein and bend it into a shape so that this piece will not fit the operator region if the co-repressor (tryptophan) is not in place.
h. Write the word "tryptophan" on one of the racquet/tennis balls. Write "repressor protein" on the carved foam piece. Now label the various parts of the noodle/operon using a Sharpie: "regulatory gene – trpR", "promoter/operator", "trpE", "trpD", "trpC", "trpB" and "trpA".
i. Place stick-on Velcro tabs on the parts of the operator and the repressor protein that fit together, so that they can stick together without being held in place. You may do the same for the repressor and the co-repressor/tryptophan ball.

2. For the inducible operon, use the prokaryotic lactose operon as an example:



Similar set-up as tryptophan, but with different labels and an inducer that distorts the repressor protein.

a. Using a serrated knife, cut an 8-inch segment from the second noodle (steps 2a-i will apply to this noodle). This will be used as the repressor protein.
b. Again, each end of the noodle/operon should feature an unlabeled/untapped section, to show the continuation of the DNA strand.
c. Wrap spirals of colored electrical tape (or shade the noodle with colored Sharpies) where each of the three gene domain regions would be found (lacZ – lacY – lacA), using a different color for each gene domain.

d. Tape or shade in the regulatory gene (lacI) region which is immediately upstream of the promoter region.
e. Using a Sharpie, draw the shape of the active form of the repressor protein onto the lower portion of the noodle in the operator region. Make the shape simple, like the one in the diagram, since you will need to carve it out using a serrated knife. Also, carve a matching shape into the regulatory repressor protein piece that you cut off in step "2a" above.
f. On the bottom side of the repressor protein, carve a wide, semi-circle shape that is a little too wide to accommodate the racquet/tennis ball. You want the repressor protein to have two shapes, one that fits the operator shape perfectly when the inducer is NOT present and one that distorts the repressor so that the carved top shape appears to pop out of the operator when the inducer fits into the bottom (you can shove a piece of coat hanger wire into the repressor to make it hold two different shapes).
g. Write "allolactose" on one of the racquet/tennis balls. Write "repressor protein" on the carved foam piece. Write "regulatory gene – lacI", "promoter/operator", "lacZ", "lacY" and "lacA" at the appropriate places along the noodle.
h. You may place stick-on Velcro tabs on both the operator and repressor protein parts so that they can stick together without being held in place. You may do the same for the repressor and the co-repressor/allolactose ball.

3. Use these models as props during class, when discussing the operon hypothesis. Have pairs of students use the props as they simulate and narrate the process of inducing or repressing an operon to regulate the genes. Make sure everyone has a chance to run through a simulation with each operon.
4. Ask the students to take notes on inducible operons and repressible operons.
5. Ask some questions to verify the depth of their understanding and clarify any misconceptions:
   a. What is more common for each type of operon—the gene non-repressed state or the repressed state? (*inducible operons are more commonly found in the repressed state while repressible operons are more often actively transcribing, thus are not repressed*)
   b. Which type of operon would be used for anabolic reactions (reactions that make new molecules)? (*repressible operons that are turned off when there is an excess of product)*
   c. Which type of operon would be used for catabolic reactions (reactions that break down other molecules)? *(inducible operons that are only turned on in the presence of the metabolite)*
   d. Are operons examples of positive feedback or negative feedback? *(negative feedback)*

HW: Ask the students to write a FR essay to question #1 from the 2003 Form B AP Biology Exam.

AP® Biology Daily Lesson Plans
Ecology Unit

(A sample lesson plan)

Day 2

I. Topic: **Population Growth**

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

Prior to class, write the following on the board: What does the capital letter K represent in ecology? What does it mean to be a K-selected species?

III. Activity One: **Population Dynamics Game** **45 minutes**

Objectives:

a) The learner will (TLW) play a memorable game that clearly shows how a single population can fluctuate according to the condition and carrying capacity of its habitat.
b) TLW practice drawing and interpreting population growth graphs.

Materials:

One "Population Dynamics" handout per student; enough small, wrapped hard candy to allow six per student; one pie pan to hold the candy; one large piece of sidewalk chalk to make a circle on cement, or a long piece of yarn to make a circle in grass/dirt.

Procedure:

1. Prior to class, find a concrete surface that is a large enough surface on which to draw a 20-ft diameter circle with chalk, or find a grass or dirt area on which to place a 20-ft diameter circle of string. Place 6 pieces of candy per student in the pie pan. Place the pie pan in the center of the circle when you start the game with your class (it helps to draw a chalk line around the pie pan, so that it stays in the correct place if the game gets rowdy).
2. Have the students space themselves out along the circle perimeter.
3. Tell the students that they are a population of elk and that each student represents one elk family that lives in a habitat together with the others that are on the circle.
4. Ask them the following questions to generate a short discussion before you begin:
    a. What do organisms in a population need? *(resources: food, water, territory/space)*
    b. How do they get these resources? *(by competing for them)*

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c. How many organisms of a population can a given environment hold? *(it depends on the amount of resources)*
d. What do we call this number? *(carrying capacity, or "K")*

5. Explain the guidelines of the game:
   a. Each student represents one elk family.
   b. One round of play equals one year of time.
   c. The pie pan holds the resources that are available in a single year.
   d. Only one resource (piece of candy) can be collected at a time. The student must return to the perimeter of the circle—touching it with both feet—after each resource has been collected to deposit it on the edge of the circle before returning to the pie pan for another resource.
   e. Every adult elk needs two resources (candies) to live through one year and every juvenile elk needs one resource to live through one year.
   f. For the first round of play every family has only one adult member.
   g. Each year, half of the families will each produce one offspring.
   h. The first year that the offspring is born it is a juvenile (and thus needs one resource).
   i. The second year the family does not produce any offspring; however the juvenile, if it lived through its first year, is now full-grown (and thus needs 2 resources).
   j. Each family must collect the needed number of resources from the pie pan in order for the members of the family to survive for that year. If they collect less than that number, they need to determine how many individuals actually survived on the lower number of resources, with juveniles dying off first (ex: if a student/elk family has 3 adults and one juvenile, the student must collect 7 resources for the entire family to survive for the year; if the student only collects 4 resources, then the juvenile and one adult will have died, since the juvenile was the most vulnerable and the 4 resources can only sustain two adults).
   k. The population will be counted at the end of every year/round of the game, when the students hold up the number of fingers that represent the elk in their family that survived that year.
   l. If a family dies off completely, they will have to wait to come back into the game when it is their turn to reproduce a juvenile.
6. Begin the game by writing down the number of elk in the starting population at time 0 on the data chart. *(This will be equal to the number of students in the class.)*
7. Remind the students that they each need 2 resources, but they must collect them one at a time and return to the perimeter (with both feet touching the line) to drop off their resources one by one.
8. Start the first round by saying "Go!". In the first round there is an abundance of resources, so all the elk should live. Tally the number of survivors and write that number on the data chart for year one.

9. Divide the circle in half and tell the students on one half that they have reproduced this year and so they now must gather enough resources for one adult and one juvenile (3 pieces of candy in total). Start round two/year two.
10. Count and record the population totals for the end of year two/round two and repeat steps 9–10 over and over until the population plateaus for 3-4 rounds.
11. Ask the students why the population has hit a plateau? *(because this is the carrying capacity of the environment with this amount of resources)* Ask them why the elk continue to reproduce even though the carrying capacity has been hit? *(biological potential is high even when it meets environmental resistance; Thomas Malthus pointed out that all organisms have a greater reproductive potential than can actually be sustained by their environment)*
12. Tell the students that a fire has occurred in the forest and the amount of available resources has dropped. Explain that the fire has served as a density-independent population control. Now take 2 resources out of the pie pan for every student in the class. Ask the students what will happen to the carrying capacity. *(it will be lower)* Ask them if this change is permanent. *(no, it will gradually go back up)* Ask them to name another density-independent population control. (*any abiotic change such as a flood, hurricane, freeze, change in humidity, or sunlight, etc.)*
13. Play several more rounds of the game, adding a few resources back to the pan with each round, until they are up to their original carrying capacity.
14. Simulate a density-dependent population control by telling the students that their area has been hit by a disease. The resources stay the same but every elk family loses a certain number of members that year. Ask the students to predict what will happen to the population over time. *(it will drop and then, eventually, rise again slowly)* Since the availability of resources has not decreased, how will the rest of the ecosystem be affected? *(other organisms will prosper due to a decrease in competition for resources)* Ask the students to give you examples of other density-dependent population controls. *(any biotic factor, such as a new predator population in the area, another organism that competes for the food, water or space resources, etc.)*
15. Allow several rounds to occur so that the elk population recovers from the disease losses.
16. When you stop playing, have the students graph the population dynamics and answer the reflection questions on their handout to turn in tomorrow.

HW: Ask the students to complete the “Population Dynamics Game” handout.

HW: Ask the students to complete the “Population Dynamics of the Kaibab Deer” handout.

Population Dynamics Game

Results:

Adults need 2 resources per year to survive.
Juveniles need 1 resource per year to survive.

Year	Population	Notes	Year	Population	Notes
1			21		
2			22		
3			23		
4			24		
5			25		
6			26		
7			27		
8			28		
9			29		
10			30		
11			31		
12			32		
13			33		
14			34		
15			35		
16			36		
17			37		
18			38		
19			39		
20			40		

Graph the data collected during the game.

Reflection Questions:

1. What is the carrying capacity of the elk habitat in this game?

2. How much was the population able to fluctuate around the carrying capacity? What were the constraints?

3. How was the elk population affected by the fire? By disease?

4. How do density-independent and density-dependent population controls differ?

5. How could the carrying capacity of this environment increase?

6. How could the carrying capacity of this environment decrease?

☐ **Exponential Growth Curve**

☐ **Logistical Growth Curve**

7. Above are graphs that show two common patterns of population growth. What type of growth pattern most closely resembles the elk population growth prior to the fire?

8. Consider the exponential growth curve. Is it possible that a population growing exponentially might eventually level off and have a logistical growth curve?

9. What would it take for this to happen?

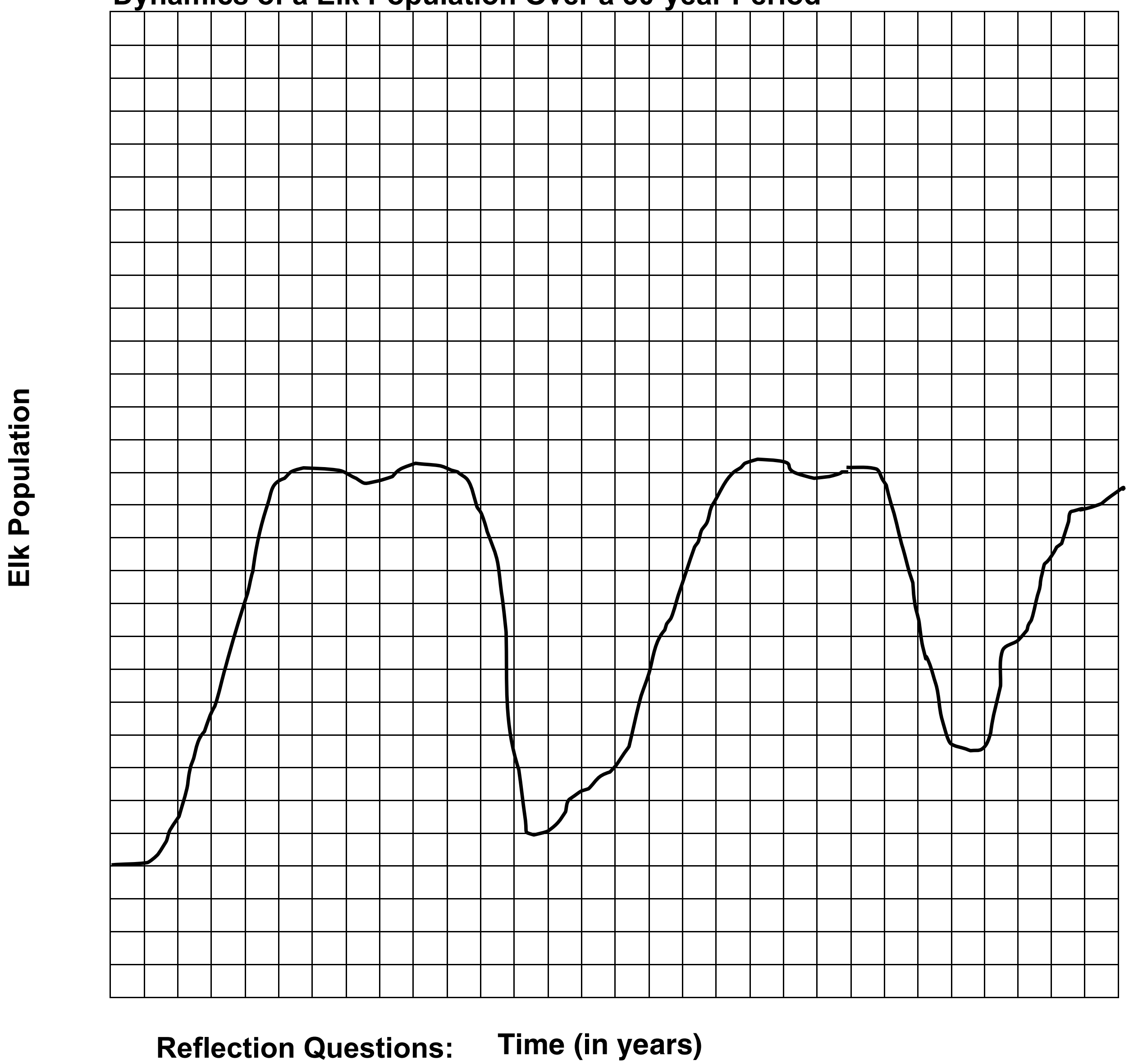
Population Dynamics Game

Teacher's Version

Results:

The students' data charts and graphs will vary some, however the population should be depicted climbing to reach carrying capacity, holding steady at carrying capacity until the fire, going down after the fire and then climbing again slowly to return to carrying capacity. The simulated disease will cause the graph line to dip and return to carrying capacity slowly, just as with the fire. Check that all students are graphing correctly—labeling axes with units, depicting steady increments on each axis and smooth curves, and providing their graph with a title.

Dynamics of a Elk Population Over a 30-year Period



Reflection Questions:

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1. What is the carrying capacity of the elk habitat in this game?

   Answers will vary, but should match the plateau of the student's graph.

2. How much was the population able to fluctuate around the carrying capacity? What were the constraints?

   Very little, because the food resources were limited.

3. How was the elk population affected by the fire? By disease?

   In both circumstances the carrying capacity of the habitat dropped, so the population dropped significantly. As more food became available, the population climbed again.

4. How do density-independent and density-dependent population controls differ?

   Density-independent controls affect all the organisms in an ecosystem, while density-dependent controls usually affect organisms unequally.

5. How could the carrying capacity of this environment increase?

   Answers may include: the elimination of competing species, expansion of the size of the habitat, a reduction in the individual needs of each organism, or an increase in the availability of resources.

6. How could the carrying capacity of this environment decrease?

   Answers may include: an increase in the needs of the organisms, an increase in the populations within the ecosystem, an introduction of more species or another population, a reduction in the amount of resources needed at the bottom of the food chain (such as caused by drought).

☐ **Exponential Growth Curve**

☐ **Logistical Growth Curve**

7. Above are graphs that show two common patterns of population growth. What type of growth pattern most closely resembles the elk population growth prior to the fire?

A logistical growth curve.

8. Consider the exponential growth curve. Is it possible that a population growing exponentially might eventually level off and have a logistical growth curve?

Yes.

9. What would it take for this to happen?

The population growth would have to slow as it approaches the carrying capacity and then level off, to plateau around the carrying capacity.

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