AP* Biology
Daily Lesson Plans Curriculum
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AP* Biology Daily Lesson Plans
Genetics Unit
(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:

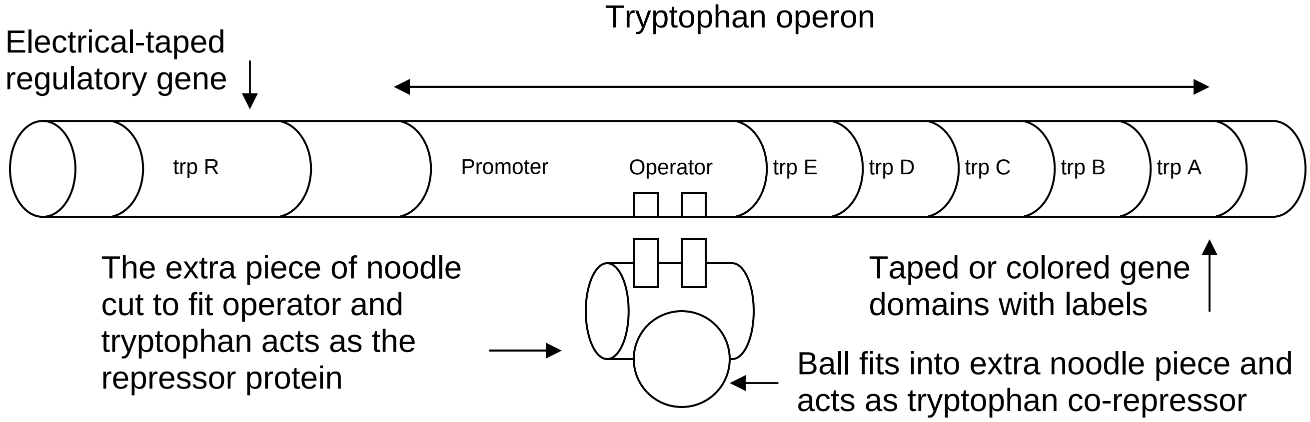
a) The learner will improve their understanding of gene regulation by making models of inducible and repressible operons.

Materials:

Each lab group will need: 2 styrofoam water "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.

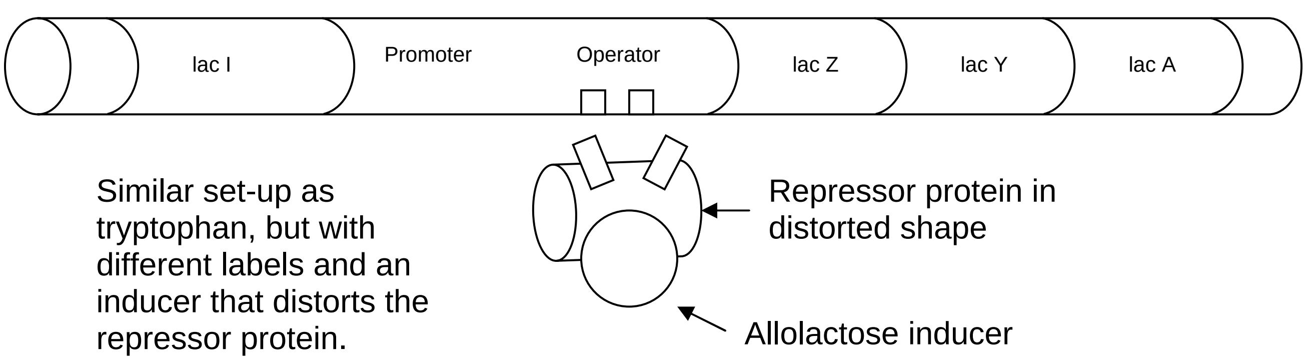
Procedure:

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
Evolution Unit
(sample lesson plan)

Day 11 – Extended Class Period

I. Topic: Protists, Evolution of Animals

II. Warm-up: 5 minutes

Prior to class, write the following on the board: How did ancestral single-celled eukaryotes develop into multicellular eukaryotes?

III. Activity One: My Favorite Protist, Part 2 40 minutes

Objectives:

a) The learner will (TLW) teach their peers about one type of protist.
b) TLW observe the diversity among the protist taxa.

Materials:

The students need their presentation materials.

Procedure:

1. Ask the students to each come before the class and introduce their protist by covering the topics that were assigned on Day 10 (and are repeated here):
   a. What is the formal name of your protist friend, and what is the nickname that your protist uses with his/her friends?
   b. Who are the famous (or not so famous) relatives of your protist?
   c. Show us a photo of your protist looking his best.
   d. What does your protist do for a living? How does he earn his carbon chains?
   e. What are the things your protist likes to do for recreation?
   f. What are some fascinating, embarrassing or neat things about your protist, that someone might not know unless they got to know him the way you have?
2. Ask the students to write a short essay in which they reflect on the diversity and uniqueness of the organisms in the kingdom Protista. Remind them to use specific examples from the introductions they just heard.

IV. Activity Two: Models of Multicellular Development 15 minutes

Objectives:

a) The learner will (TLW) review terminology associated with the study of the evolution and development of animals.
b) TLW make dough models to learn about the types of body cavities and symmetry seen in the major phyla of eukaryotes.

Materials:

~6cm-diameter ball of modeling dough and a small pinch of dough of another color for each student

Special note: You can make colored dough – enough for an entire class – using the following recipe: 6 cups of flour, 2 cup water, ¾ cup salt and 6 tablespoons of vegetable oil (if you place all the ingredients in a large plastic Ziploc bag, you can mix it without getting your hands sticky). Divide the dough in half and a different color of food dye to each bag.

Procedure:

1. Ask the students to form their dough into an asymmetrical shape. Ask them which phyla has organisms that are asymmetric? (*Phylum Protista, ex: amoeba; Phylum Porifera ex: sponges)*
2. Ask the students to make a shape that is radially symmetric. Ask them which phyla have organisms with radial symmetry? *(P. Cnidaria; P. Ctenophora; P. Echinodermata)*
3. Ask the students to make a shape that is bilaterally symmetric. Ask them which phyla have organisms with bilateral symmetry? (*all the worms; Molluska; Arthropoda; Brachiopoda; Chordata)*
4. Ask the students to make a pancake with the dough and then turn that flat shape into a blastula by folding it over into a hollow ball. Have them press one half of the ball into the other half, so it looks like a half moon to simulate a blastula undergoing gastrulation. Ask them to cut the gastrula in half to see that it now has two layers, just as a ball of dividing cells has two cell layers.
    a. What is the name of the outer layer of cells? *(ectoderm germ cells)*
    b. What will the outer layer of cells eventually become? (*they will become the ectodermal germ cells that give rise to the organism's external covering and the nervous system)*
    c. What is the name of the inner layer of cells? *(the endoderm germ cells)*
    d. What will the inner layer of cells become? (*the endoderm cells will become the epithelial tissue that lines the digestive, respiratory and excretory tracts of the organism)*

e. The most simple phyla have only two germ cell layers. Which phyla are they? *(P. Cnidaria and P. Centophora, which have no true internal organs)*
f. What is the space between the two layers called? *(the blastocoel)*
g. What is the opening to the outside called? *(the blastopore)*

5. The mesoderm is a third layer of germ cells that will produce the muscles, the coelom, the skeleton, the connective tissue and most of the internal organs. From which cells in the gastrula does the mesoderm arise? *(during the early stages of development, the gastrula begins to accumulate a germ layer, either just inside the blastocoel near the blastopore or deep inside the gastrula, from an infolding of the endoderm– the area where this begins depends on whether the organism is a protostome or a deuterostome).* Ask the students to add a layer of mesoderm cells – represented by a different color of dough – to either the blastocoel or the deep interior of the gastrula (depending on whether they are making a protostome or a deuterostome.
   a. What will the blastopore eventually become? *(if the organism is a protostome, the blastopore will become the beginning of the digestive tract (the mouth); if it is a deuterostome, then the opening will become the end of the digestive tract (the anus))*
   b. Which phyla are protostomes and which are deuterostomes? *(Molluska, Annelida and Arthoropoda are protostomes; while Chordata and Echinodermata are deuterostomes)*
   c. How else do protostomes and deuterostomes differ? *(the cleavage pattern created during cell division is different -- protostomes cleave spirally in a pattern with a set stopping point, while deuterostomes cleave radially in an indeterminate or unlimited growth pattern)*

6. Ask your students to take a minute to write notes and sketch illustrations of the terms that have been reviewed.
7. Continue to guide the students through the changes that would occur during neurulation by asking them to visualize the position of the notochord and the neural plate. Ask them to pinch the dough up into the shape of the neural crest that would be the result of the neural plate folding upon itself.
   a. What will the notochord eventually become? *(the vertebral column)*
   b. Where will the spinal cord and brain be positioned in this model? *(in the neural tube)*

8. Ask your students to finish their notes on this activity tonight by comparing the diagrams of gastrulation for a protostomes and deuterostomes and writing description of how they are different.

V. Activity Three: Becoming Phylum Experts — 10 minutes

Objectives:

a) The learner will (TLW) learn a great deal about a single phylum.
b) TLW become aware of the diversity and uniqueness of a single phylum.

Materials:

none

Procedure:

1. Let the students know that they will each research a single phylum and become the expert that the class turns to questions about that phylum.
    a. They will research the characteristics of their phylum and make a visual aid (to be displayed in the classroom) with a concise list of the most important facts about the phylum in large bold letters for easy reference.
    b. When questions come up regarding this phylum, the phylum expert will answers questions or find out the answer to the questions.
    c. The student should be familiar with the animals that are in their phylum.
    d. The student should be able to answer any simple questions about the phylum, such as developmental traits and common habits.
2. Ask the students to begin their research tonight on their choice of phylum from the list below:

    P. Ctenophora
    P. Nematoda
    P. Porifera
    P. Chordata
    P. Platyhelminthes
    P. Nemertea
    P. Cnidaria
    P. Mollusca
    P. Arthropoda
    P. Brachiopoda
    P. Echinodermata
    P. Rotifera

VI. Activity Three: Phylogeny Mobiles — 20 minutes

Objectives:

a) The learner will (TLW) be introduced to the taxonomic organization of eukaryotes.

b) TLW look for significant developments in evolution.
c) TLW make a mobile that represents the taxonomic organization of the major branches in eukaryotic evolution.

Materials:

One copy of the "Evolution and Development Mobile of the Major Eukaryotic Phyla" handout per student; art supplies (such as modeling foam, pipe cleaners, yarn, beads, etc.)

Procedure:

1. The handout details the procedure and expectations for this project, so students can begin immediately. However, you may want to discuss the terms that are introduced if they have not yet read the chapters on embryotic development and body plan arrangements. You may also need to discuss the organisms that are in each of the major phyla.

HW: Ask the students to finish their phylogeny mobiles at home and bring them to class, ready to hang from the ceiling in three days.

Special note: When the students bring their mobile in, they will need to be balanced in order to hang from the ceiling properly. It helps to keep a small amount of modeling dough on hand for balancing the poles on this day.

HW: Ask the students to begin researching their chosen phylum.

Evolution and Development Mobile of the Major Eukaryotic Phyla

Due on:_________

Introduction:

During the evolution of eukaryotes, there were several major changes that occurred in the embryotic development of some taxonomic groups as well as significant changes in the overall body plan of some organisms. I would like you to construct a 3-dimensional mobile that shows the progression of these developments as well as the fundamental relationships that exist between the phyla in the Domain Eukarya.

Objectives:

- to learn the evolutionary relationships between the major eukaryotic phyla.
- to create a 3-dimensional model of the evolutionary relationships an important developmental milestones that can be referred to throughout the semester.

Procedure:

1. Using modeling foam or some other form of lightweight art, make representative organisms from each of the major phyla listed below:

    P. Ctenophora
    P. Nematoda
    P. Porifera
    P. Chordata
    P. Platyhelminthes
    P. Nemertea
    P. Cnidaria
    P. Mollusca
    P. Arthropoda
    P. Brachiopoda
    P. Echinodermata
    P. Rotifera

2. Before the models dry, make a hole in each and thread a piece of yarn or string through each one.
3. Using the dried models to represent each phylum, arrange the phyla into the evolutionary relationships, they have with one another (if there is more

than one hypothesis regarding the relationship between two taxa, choose the relationship that you feel is best supported).

4. Using wooden dowels, thin PVC pipe or some other lightweight but sturdy support, create a mobile that holds the representative organisms in their branched arrangement.
5. Place each of the major embryotic or body plan developments listed below at their appropriate nodes along the evolutionary tree (you might use pairs of labeled notecards stapled together around the dowel or yarn, or use any other technique that is neat and easy to see).

   No true tissues
   True tissues
   Acoelomates
   Psuedocoelomates
   Coelomates
   Protosomia
   Deuterostomia
   Diploblastic
   Triploblastic
   Cephalization
   Asymmetric
   Radial symmetry
   Bilateral symmetry

6. If necessary, finish your mobile at home, then bring it to class ready to be hung from the ceiling. Be prepared to spend time centering and balancing each branch of the mobile, to make it stable. You may need extra string, adhesive or any other supplies you used originally to create the mobile.

AP* Biology Daily Lesson Plans
Botany
(sample lesson plan)

Day 14 – Extended Class Period

I. Topic: Plant Hormones

II. Warm-up: 5 minutes

Prior to class, write the following on the board: Come to the board and list one plant hormone or describe one of the things a particular plant hormone does.

III. Activity One: The Effects of Plant Hormones 20 minutes

Objectives:

a) The learner will (TLW) consider how plant hormones are similar to or different from animal hormones.
b) TLW participate in a simple experiment that measures the effects of an airborne plant hormone.

Materials:

For each student, pair of students or lab group: one overripe, brown banana; two green, unripe bananas (with no brown spots or bruises); two brown paper lunch bags.

1. Begin the class with a discussion of the warm-up.
2. Give each student two green unripe bananas, one brown (overripe) banana and two paper bags.
3. Have the students use a pencil (pen ink might contain chemicals that influence the ripening process) to draw a data chart like the one below on each paper bag.

Date	# of Spots

4. Ask the students to each count the number of spots on their green bananas (ideally, there will be no spots). Ask them to write the number of spots found on the banana on the chart on one of the paper bags and have them place the green banana inside the bag.
5. Have them repeat steps 3-4 with the other green banana and place it in the second bag.
6. Ask them to place one overripe, brown banana in the first bag.
7. Ask them to close each paper bag by firmly folding the edge over a few times.
8. Gently place the paper bags that each contain two bananas in one area and the bags that each contain only one banana in a different area, so that the gases emitted from the two-banana bags cannot influence the single-banana bags (use two different classrooms, or you can place all the bags of a single type in separate containers). Include your students in the choosing of the two storage locations, discussing whether proposed locations offer equal amounts of sunlight, the same temperature, and/or any other factors that they feel may influence the outcome of the experiment.
9. Allow the bags to sit at room temperature until tomorrow.
10. Ask the students to each write down the question that is being tested in this experiment.
11. Ask them to each write down one hypothesis and a null hypothesis for this experiment.
12. Have the students share and discuss what they have written for the test question and the hypotheses.
13. At the beginning of each subsequent class period, have the students count the spots on each unripe banana as the spots emerge and record the information collected on the data chart of the corresponding bag. They will repeat this step until the bananas have spots that begin to merge with one another, such that they cannot be counted accurately.
14. At the conclusion of the experiment, have all members of the class share their data so averages can be calculated for the number of spots present on each of the unripe bananas each day of the experiment.
15. Ask the students to graph the data averaged for each day of the experiment to see how the control group and the experimental group differed on each day of the experiment.
16. Ask the students to draw some conclusions from the class results about the influence of a ripe banana on an unripe one. Ask them to explain how one banana can influence another when the bananas are not connected by vascular tissue.

IV. Activity Two: The Effects of Plant Hormones 65 minutes

Objectives:

a) The learner will (TLW) design a lab experiment using plant hormones.
b) TLW critique the experiments designed by their peers and choose the best one.
c) TLW perform the selected experiment.

Materials:

A plant hormone (such as auxin, gibberellins, abscisic acid, or brassinolide, obtained from a biological supply company); a flat of 30-50 small plants of one species from a nursery, or fresh packages of seeds, to use as experimental subjects (or the leftover bean seedlings if there are enough of each developmental group); plant propagation materials such as watering bottles, clay pots or flats, potting soil, trowels, etc.

Procedure:

1. Prior to class, soak the seeds to be used as experimental subjects in water for one night.
2. Ask the students to each write 1-2 questions that could be tested and answered with the supplies available in the classroom. Ask them to come to the board and write their experiment questions on the board.
3. As a class, eliminate the questions that are not possible to test and choose the most interesting of the remaining questions.
4. Ask the students to divide into lab groups and give them about 10 minutes to each design an experiment using plant hormones.
5. Have each lab group share their experiment design in front of the class.
6. Ask the class to decide on the best experiment procedure (a composite or revised version might be best).
7. Have the class design a data collection chart on the board that can be copied and used by all of the lab groups.
8. Have the lab groups perform the agreed upon experiment.

1. Because it will take time for the plants to react to the hormone they are subjected to, this experiment will very likely take about 2 weeks and require data collections every two to three days. Over the next 2 weeks, ask the students to collect data from the experiment at the beginning of each class period or as scheduled.
2. When the experiment is complete, ask the lab groups to share their results so that all are able to analyze the data using the appropriate graphs and statistical calculations and have the students each complete a lab report.

HW: Ask the students to be prepared for an in-class FR essay tomorrow on plant responses to light.

AP* Biology Daily Lesson Plans
Ecology
(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 observe the principles of Malthus and realize the influences of biotic potential and environmental resistance.

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)*
    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.

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?

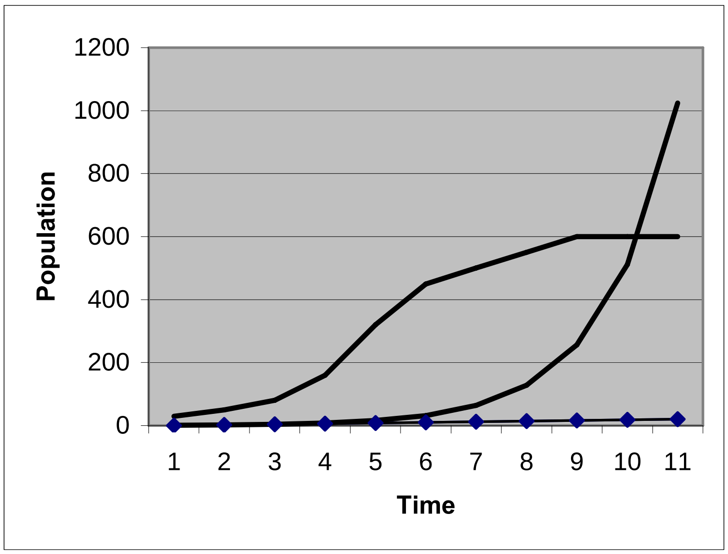
2. How much was the population able to fluctuate around the carrying capacity? What were the constraints?

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?

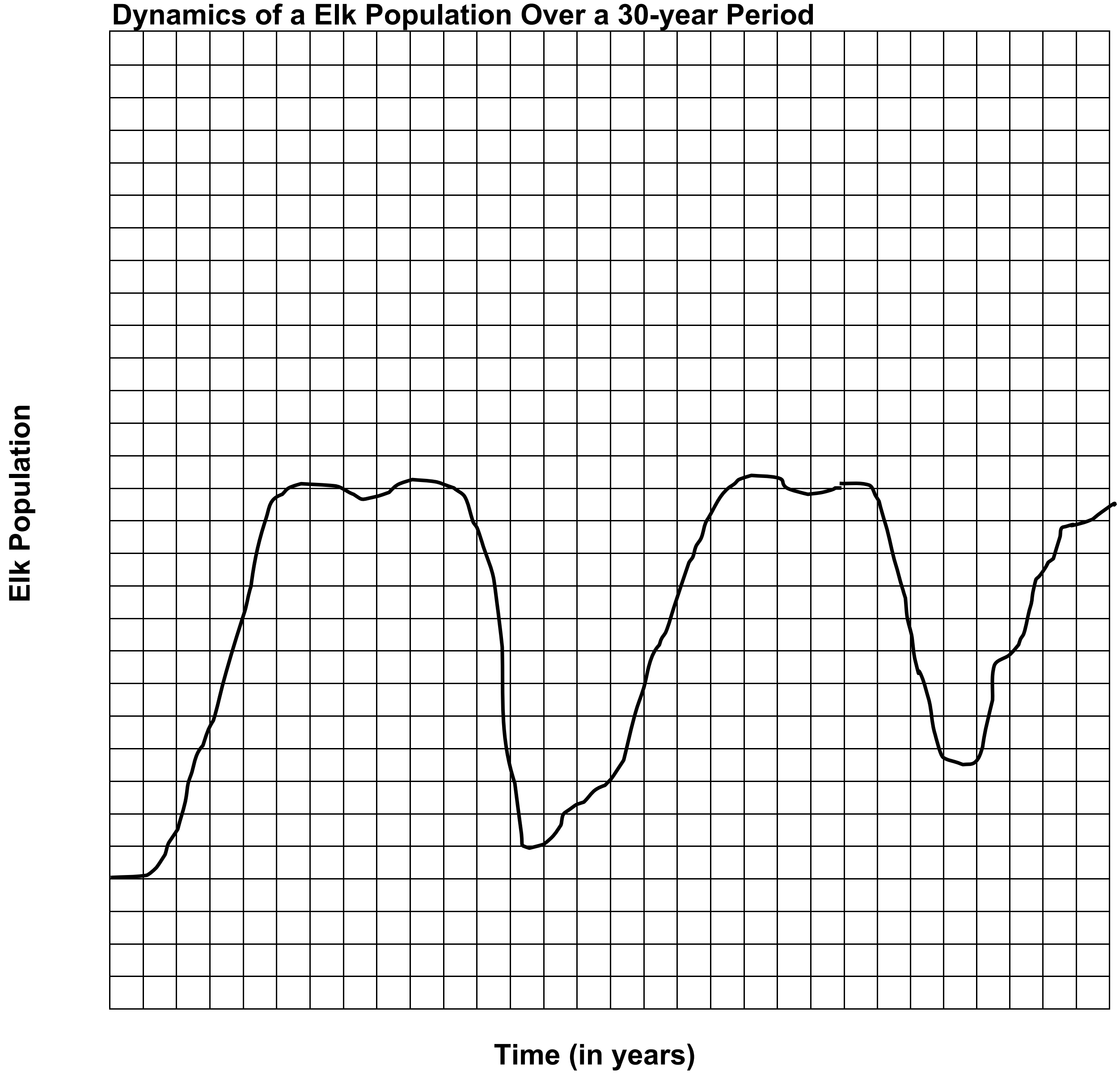
Population Dynamics Game

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



Conclusions:

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.

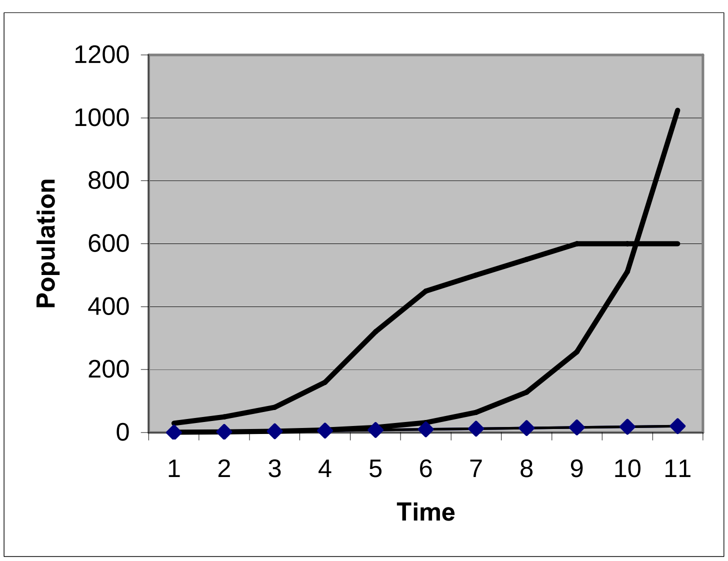
2. How much was the population able to fluctuate around the carrying capacity? What were the constraints?
   Very little, because the food resources were limited.

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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