470134-764

AP® Biology Investigation #1:

Artificial Selection

Meets Revised College Board AP® Biology Standards

WACP470132-870

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abstract

Populations of organisms change their genetic makeup through the process of natural selection/differential reproduction. Natural selective pressures come from the organism's environment (for example, predators or ambient temperatures). Selection causes an alteration in the prevalence of the genes regulating the expression of phenotypes in a population of organisms (for example, low temperatures might increase the prevalence of a gene that increases the density of hairs in fur). This occurs naturally over many generations and underlies the process of evolution.

In this lab, students artificially select one or more phenotypes in one generation of a population of fast growing plants to determine whether they can change the prevalence of that phenotype in the next generation of plants. The students learn to apply statistical analyses to evaluate the probability that a conclusion is significant or not. Further, they evaluate the interplay between environmental pressures on plant phenotypes and how they may or may not be manifested as phenotypic changes that are passed to the next generation.

required prior knowledge

Students should:

- be able to make and record good observations.
- understand how selection influences populations of organisms.
- It is also helpful if students have some understanding of evolution and natural selection.

activity learning objectives

In this investigation, students will perform activities to help them answer the following question:

Can extreme selection change the expression of a quantitative trait in a population in one generation?

Working in groups, students will investigate natural selection as a major mechanism of evolution, to understand how selective breeding can artificially select for certain characteristics (phenotypes). Evolution is a result of genetic variation and the environmental influences that determine survival. Artificial selection (also known as "selective breeding") has been used for many years in the agricultural industry to improve and/or modify organisms for traits that benefit the industry and/or are considered to be desirable to consumers (for instance, size, fat content, color, smell, etc.). Students will categorize plants based on a predetermined trait, using both quantitative and qualitative methods. Students will then use this categorization to selectively breed a subset of organisms.

materials checklist

For a list of replacement items, visit: www.wardsci.com, and click on the AP Biology tab for this kit/item #.
Download the latest digital activity guide for this item at connect.wardsci.com

materials included in kit:

- 1.5 lbs Vermiculite
- 1 Stake & Twist Tie Set
- 2 Professional Jiffy Greenhouses with peat pellets
- 4 Plant Fertilizer, 2.75 g
- 1 Arabidopsis, Wild Type, 300 seeds (contained in microcentrifuge tube)
- 40 Plant Labels, 5"
- 45 Pipets, 6"
- 30 Microfuge Tubes, 1.5 mL
- 1 Instructions (this booklet and student guide)

materials needed but not provided:

- Digital camera
- Magnifiers
- Jug for watering, mixing fertilizer
- Graduated cylinders to measure water (1-2 L)
- Water
- Light timer to control photoperiod
- Paper towels
- Rulers
- Grow light
- Lab notebook

optional materials (suggested for activity 3)

- Beakers for transporting peat pellets to and from growing area
- 3" plastic pots
- Soil
- Additional Jiffy pellets and arabidopsis seeds for student directed experiments
- Other materials as determined by students experiment design

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standards alignment

This lab activity is aligned with the 2012 AP Biology Curriculum (registered trademark of the College Board). Listed below are the aligned Content Areas (Big Ideas and Enduring Understandings), the Learning Objectives, and the Science Practices of the lab as described in AP Biology Investigative Labs: An Inquiry-Based Approach (2012). *This is a publication of the College Board that can be found at:*

http://media.collegeboard.com/digitalServices/pdf/ap/APBioTeacherLabManual2012_2ndPrt_lkd.pdf

Big Ideas	**1**	The process of evolution drives the diversity and unity of life.
	3	Living systems store, retrieve, transmit, and respond to information essential to life processes.
Enduring Understandings	**1A1**	Natural selection is a major mechanism of evolution.
	1A2	Natural selection acts on phenotypic variations in populations.
Learning Objectives	**1.1**	The student is able to convert a data set from a table of numbers that reflect a change in the genetic makeup of a population over time and to apply mathematical methods and conceptual understandings to investigate the cause(s) and effect(s) of this change.
	1.2	The student is able to evaluate evidence provided by data to qualitatively and quantitatively investigate the role of natural selection in evolution.
	1.3	The student is able to apply mathematical methods to data from a real or simulated population to predict what will happen to the population in the future.
	1.4	The student is able to evaluate data-based evidence that describes evolutionary changes in the genetic makeup of a population over time.
	1.5	The student is able to connect evolutionary changes in a population over time to a change in the environment.
Science Practices	**1.5**	The student can re-express key elements of natural phenomena across multiple representations in the domain.
	2.2	The student can apply mathematical routines to quantities that describe natural phenomena.
	5.3	The student can evaluate the evidence provided by data sets in relation to a particular scientific question.
	7.1	The student can connect phenomena and models across spatial and temporal scales.

time requirements

	TIME FRAME	TEACHER TASK(S)	STUDENT TASK(S)
PRE-LAB PREP	2 days prior to starting lab	Cold snap. (See page 11, Step 1)	
	1 day prior to starting lab	Expand peat pellets. (See page 11, Step 2)	
Weeks 1-3	Days 1-2	Plant seeds before class, unless you decide to have students do this step. (see page 16, Steps 1-3)	Go over background material; Start Lab Activity 1: Plant seeds (*); set up notebook, (* - Teacher may do this before class to save time)
	Days 1-21		Observe plants; record data; Maintain plants (approx. 10 minutes/day)
	Day 21		Analyze data and choose traits during one 45-min lab period.
Weeks 4-6	Days 22-42		10 minutes a day observation and care including collecting seed pods.
Weeks 7-8	Days 43-56	Drying time can be extended to accommodate scheduling	Dry seeds
	Day 54	Cold snap seeds (students or teacher) 15 min	Cold snap seeds (students or teacher) 15 min
	Day 55	Expand peat pellets (students or teacher) 15 min	Expand peat pellets (students or teacher) 15 min
	Day 56 (F1 Day 0)		Plant F1 generation 30 min (optional lab period)
Weeks 9-11	Days 57-76 (F1 Weeks 1-3)		Observe plants; record data; Maintain plants (approx. 10 minutes/day)
	Day 77		Analyze data

lab specific safety:

- If you are setting up a light system for your plants, make sure that water does not get on electrical connectors.
- Make sure that fertilizer and/or water do not come in contact with electrical connectors.

general safety:

- The teacher should 1) be familiar with safety practices and regulations in his/her school (district and state) and 2) know what needs to be treated as hazardous waste and how to properly dispose of non-hazardous chemicals or biological material.
- Consider establishing a safety contract that students and their parents must read and sign. This is a good way to identify students with allergies (e.g., latex) so that you (and they) will be reminded of specific lab materials that may pose risks to individuals.
- Students should know where all emergency equipment (safety shower, eyewash station, fire extinguisher, fire blanket, first aid kit etc.) is located.
- Require students to remove all dangling jewelry and tie back long hair before they begin.
- Remind students to read all instructions, SDSs and live care sheets before starting the lab activities and to ask questions about safety and safe laboratory procedures. The most updated versions of live care sheets can be found at www.wardsci.com. Updated SDSs can usually be found on each chemical manufacturer's website.
- In student directed investigations, make sure that collecting safety information (like SDSs) is part of the experiment procedure.
- As general laboratory practice, it is recommended that students wear proper protective equipment, such as gloves, safety goggles, and a lab apron.

at the end of the lab:

- Review local regulations or consult with local authorities before disposing of any chemicals in the trash or down the drain.
- All laboratory bench tops should be wiped down with a 10% bleach solution or disinfectant to ensure cleanliness.
- Remind students to wash their hands thoroughly with soap and water before leaving the laboratory.

teacher notes

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