Game Changing Revisions in AP Biology

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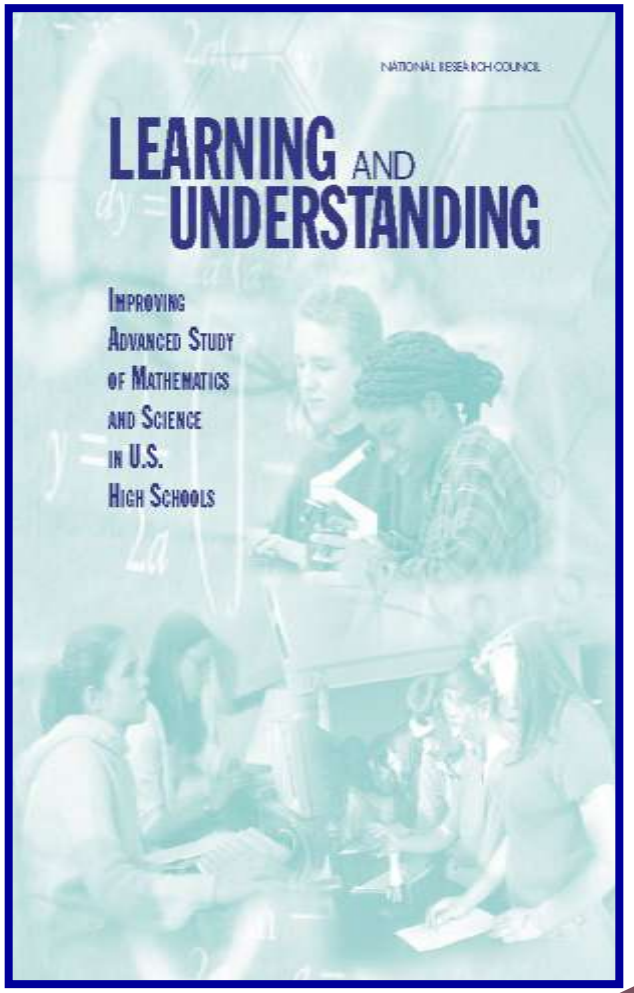
AP Science Course & Exam Review

Science Design: Background

A National Research Council Report (*2002*) identified several opportunities to improve math and science education in the US.



- Courses should emphasize deep understanding rather than comprehensive coverage.
- Programs should reflect current understanding of learning in the discipline.
- Programs should reflect current research directions within the disciplines.
- Courses should include a strong emphasis on inquiry and reasoning.

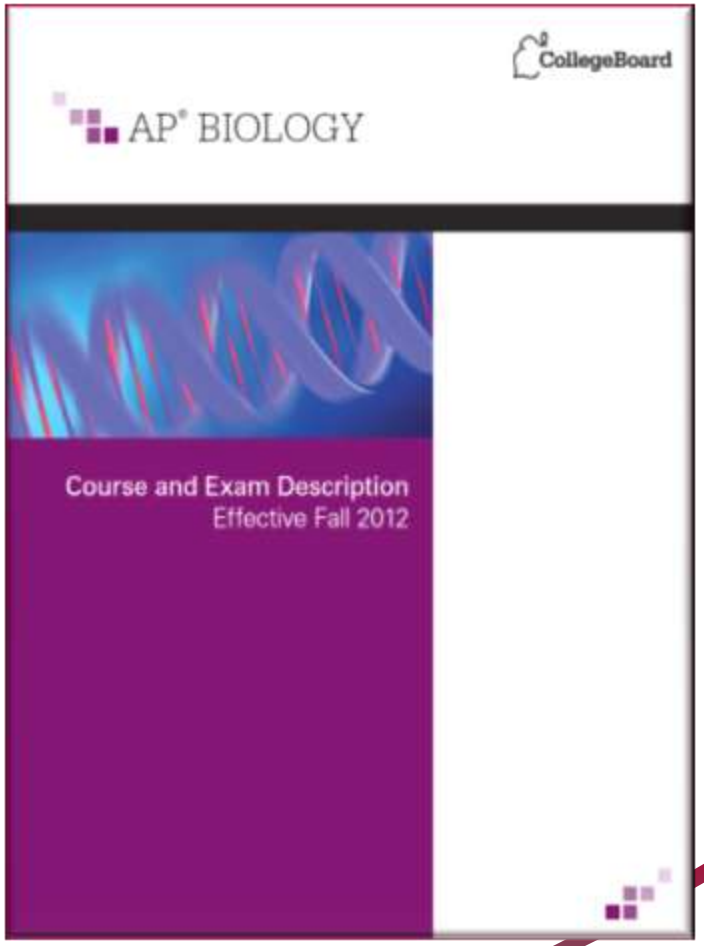
College Board's AP Biology Revision

Produce a more engaging program of study which will:

- reduce breadth of content and increase depth of understanding
- increase use of essential reasoning and inquiry
- improve relevance of course to students
- focus on science as a process
- meld content with science practice skills
- incorporate more mathematical skills practice and reasoning
- focus on student competencies

Reduction in Content and Increase in Depth

- New approach: Essential content + skills + inquiry
- New structure: 4 Big Ideas, 17 Enduring Understandings
- New transparency in exam: Learning Objectives, Formula List, Use of Calculators
- Breadth reduced in four ways:
  1. Factual recall reduced for exam
  2. Teacher choice of illustrative examples
  3. Explicit exclusion statements in Curriculum Framework
  4. Specific content reductions



Curriculum Framework: Big Ideas

The unifying concepts or Big Ideas increase coherence both within and across disciplines. A total of Four Big Ideas:

BIG IDEA 1 — The process of evolution drives the diversity and unity of life.

BIG IDEA 2 — Biological systems utilize energy and molecular building blocks to grow, reproduce, and maintain homeostasis.

BIG IDEA 3 — Living systems retrieve, transmit, and respond to information essential to life processes.

BIG IDEA 4 — Biological systems interact, and these interactions possess complex properties.

Science Practices for AP Biology

1.0 The student can use representations and models to communicate scientific phenomena and solve scientific problems.

2.0 The student can use mathematics appropriately.

3.0 The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.

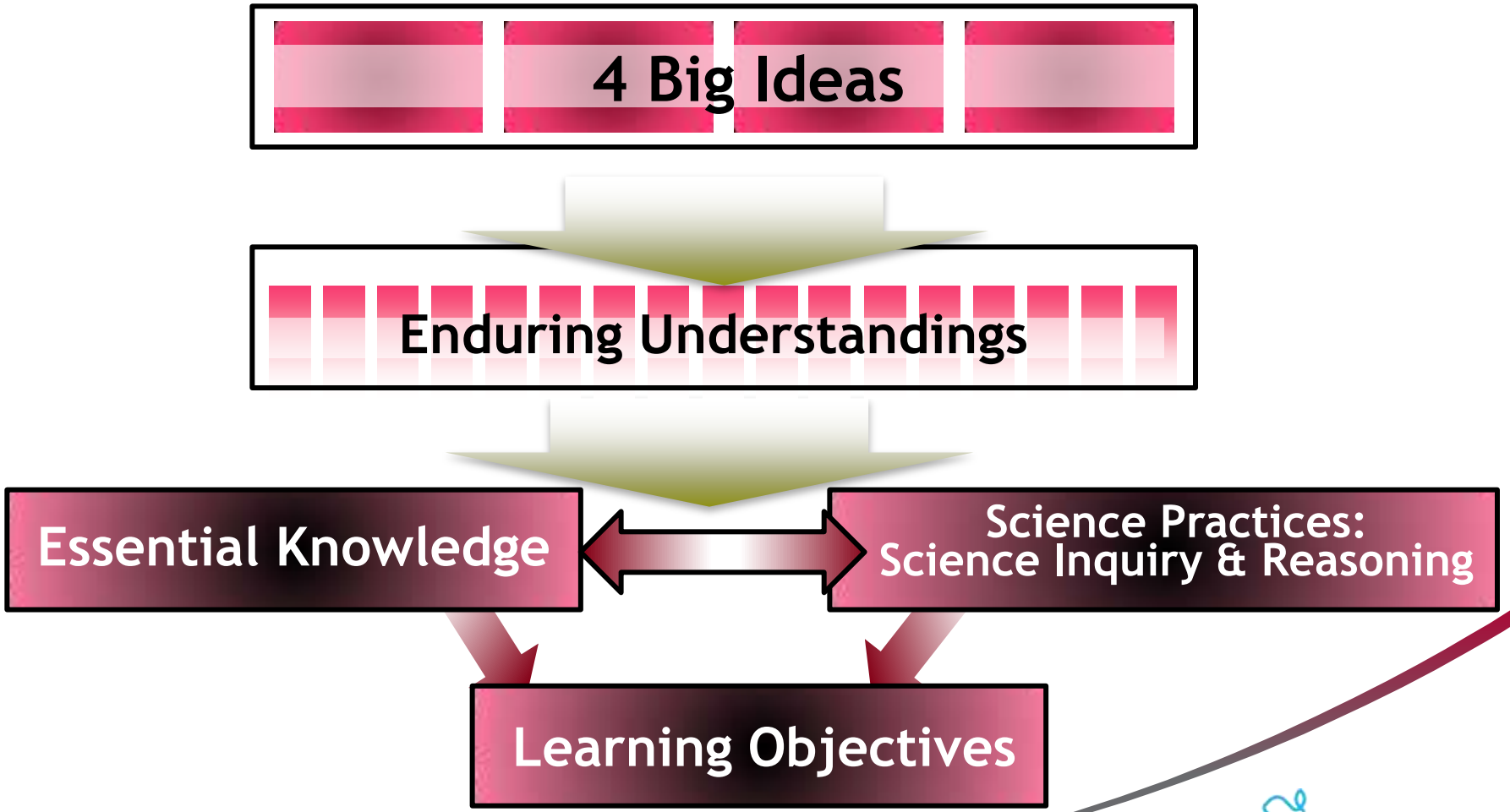
4.0 Student can plan and implement data collection strategies in relation to a particular scientific question.

5.0 The student can perform data analysis and evaluation of evidence.

6.0 The student can work with scientific explanations and theories.

7.0 The student can connect and relate knowledge across various scales, concepts, and representations in and across domains.

Structure of the AP Biology Curriculum Framework



AP Integrating the Content and Science Practice

Content

Essential Knowledge 1.B.2
Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested

Science + Practice

Science Practice 5.3
The student connects phenomena and models across spatial and temporal scales

Learning Objective

Learning Objective (1.B.2 & 5.3)
The student is able to evaluate evidence provided by a data set in conjunction with a phylogenetic tree or a simple cladogram to determine evolutionary history and speciation

Teacher Choice of Illustrative Examples

Rather than trying to cover all topics, teachers have flexibility to focus on **one specific example** for in-depth study, linking example to concept and Big Idea

Example from Big Idea 3: Genetics

3A3c. Certain human genetic disorders can be attributed to the inheritance of single gene traits or specific chromosomal changes, such as nondisjunction.

To foster student understanding of this concept, instructors can choose an illustrative example such as:

- Sickle cell anemia
- Tay-Sachs disease
- Huntington's disease
- X-linked color blindness
- Trisomy 21/Down syndrome
- Klinefelter's syndrome

Labs: Principles and Requirements

- AP *Biology Investigative Lab Manual: An Inquiry Approach*
- Thirteen student-directed and inquiry-based labs
- Teachers must include a minimum of eight inquiry-based lab investigations in their AP Biology course
- Courses must spend a minimum of 25% of instructional time on labs

The New AP Biology Course Emphasizes Inquiry-Based & Student-Directed Labs

Topic	Previously	Now
Primary Question	A primary question framed the lab	Students generate their own questions for investigation
Alignment to Big Ideas	Not as clearly tied to the curriculum	Labs are clearly tied to Big Ideas, enduring understandings, science practices, and the learning objectives
Experiments	Experiments were teacher-directed	Students design and conduct their own experiments, based on investigative questions they pose for themselves
Variables	Students are told which variables to investigate	Students choose which variables to investigate
Steps	Each lab provided clear steps to follow	Students design their own experimental procedures
Tables and Graphs	Tables and graphs were provided for the students to fill in	Students construct their own tables and graphs for presentations
Providing Conclusions	Students were given specific questions to answer	Students determine how to provide their conclusion

Evidence-Centered Design of Exam

No test items will focus on low cognitive level or declarative knowledge/recall

For each exam item, students will either produce the evidence (CR) or engage with the evidence (SR/MC)

- explain
- justify
- predict
- evaluate
- describe
- analyze

- pose scientific questions
- construct explanations
- construct models
- represent graphically
- solve problems
- select and apply mathematical routines

Organization of the New AP Biology Exam

- **Section 1 (90min):**
  - 63 Multiple Choice + 6 Grid-In questions
  - 50% of exam weight

- **Section 2 (*90 min):**
  - 8 Free Response questions
    - 6 Short free response questions (3-4 pts each)
    - 2 long free response question (one lab based & 10pts each)
  - 50% of exam weight

**10 minutes required reading time + 80 minutes response time*

Positive Feedback for the AP Biology Revisions

"The changes to the AP Biology course provide greater emphasis on the type of ***scientific inquiry that increases reasoning skills and conceptual understanding****….*

…These revisions represent ***a major reform in science education*** *that will enable many more young Americans to experience science as a special "way of knowing" about the world."*
Bruce Alberts, Editor-in-Chief, ***Science***

"The College Board took criticisms to heart, and has been ***working with hundreds of college professors and high school teachers to develop the new approach."***

NY Times (Jan 2011)

Immediate Impacts of AP Biology Changes

Approximately 10,000-12,000 high school biology teachers across the country all changed the way they taught AP Biology…at the same time

- For many teachers, they had to replace all their laboratory investigations.
- For all of them, they had to incorporate inquiry activities throughout the course, not just use inquiry in a few labs.
- For some, incorporation of mathematical skills is a challenge.

In May, ~180,000 students will take the new AP Biology exam

What's The Impact Of Curriculum Changes On New AP Biology Exam?

- *Because of use of Big Ideas*….
  - in 2008, 12% of questions had something to do with evolution
  - In new 2013 exam, 35% of questions have something to do with evolution
- *Because of emphasis on science practice and mathematical skills*…new types of questions are being asked, e.g., grid-ins
- *Because of use of evidence…*the number of Multiple Choice questions was reduced from 100 questions on last year's exam to 63 on this year's exam.

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Lab Investigation Chapter
Big Idea 1: Evolution

Investigation Title: Determining Evolutionary Relationships using BLAST

Goal: **Help students to learn how to analyze cladograms and understand evolutionary relationships**

Overview

- New fossil discovery with genetic information in the form of several gene sequences isolated from the fossil provided to students
- Students' task is to use BLAST (Basic Local Alignment Sequencing Tool) to determine where the newly discovered fossil fits into an already pre-constructed cladogram.
- Prior to BLAST, students form a hypothesis based on morphological details provided about the fossil.
- They use BLAST to test their hypothesis.
- Saved queries will be preloaded to save time with BLAST configuration
- Students download gene files from the AP Biology College Board Website & then upload them on the BLAST website
- Students can work in teams or individually
- Students have to use evidence-based reasoning to reject or accept their initial hypothesis.

Lab Investigation Chapter
Big Idea 1: Evolution

Investigation Title: Building and Exploring a Mathematical Model for Evolution

Overview

- Revision of Hardy-Weinberg Lab (AP Lab 8)
- Simulated population in HW equilibrium is problematic
- Revised lab eliminates this problem through the power, importance & use of computer/math models
- The computer allows students to try out many combinations of trials and population size in a short time.
- Building the model helps students understand limitations and power of models to explain complex phenomena
- Students derive HW equation based on conclusions from their model.
- Students are encouraged to build parameters into their models and build multi-generational models before moving on to explore more powerful computational models.

	frequency of	A =	0.6														
	frequency of	B =	0.4														
								number of each genotype									
				gametes			zygote	AA	AB	BB							
				A	B		AB	0	1	0							
				A	A		AA	1	0	0							
				A	B		AB	0	1	0							
				A	A		AA	1	0	0							
				B	A		BA	0	1	0							
				B	B		BB	0	0	1							
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				A	A		AA	1	0	0							
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				A	A		AA	1	0	0							
				A	A		AA	1	0	0							
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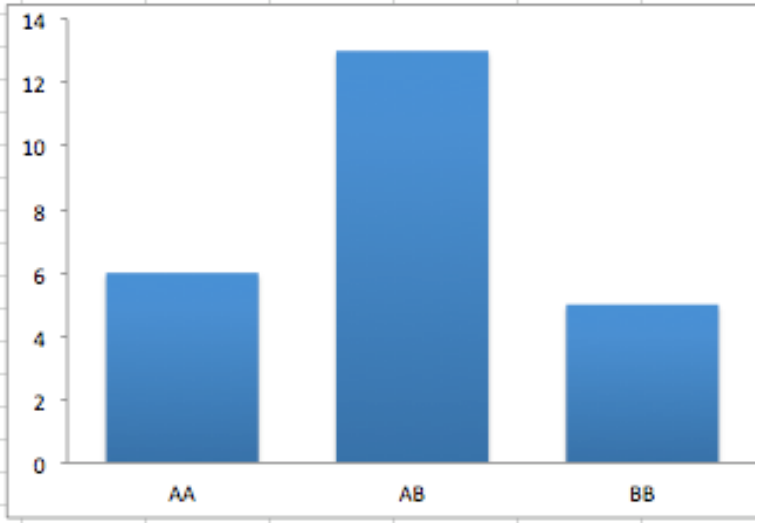
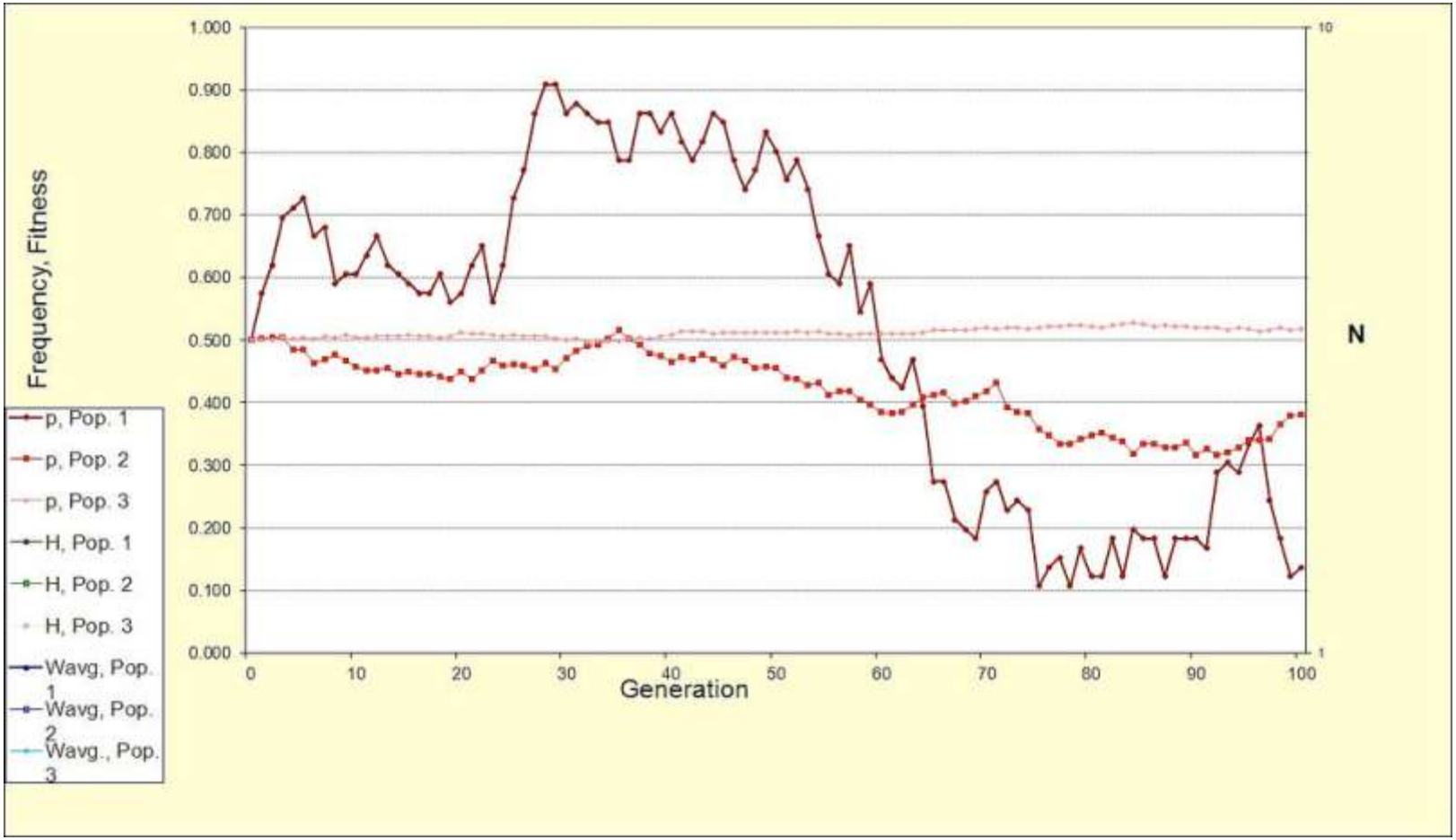
				B	A		BA	0	1	0							
				B	A		BA	0	1	0							
				A	B		AB	0	1	0							
	sums for each genotype -->							6	13	5							
								A		B							
	number of each allele in next generation -->							25		23							
								p		*q*							
	gene frequencies in the next generation -->							0.52		0.48							



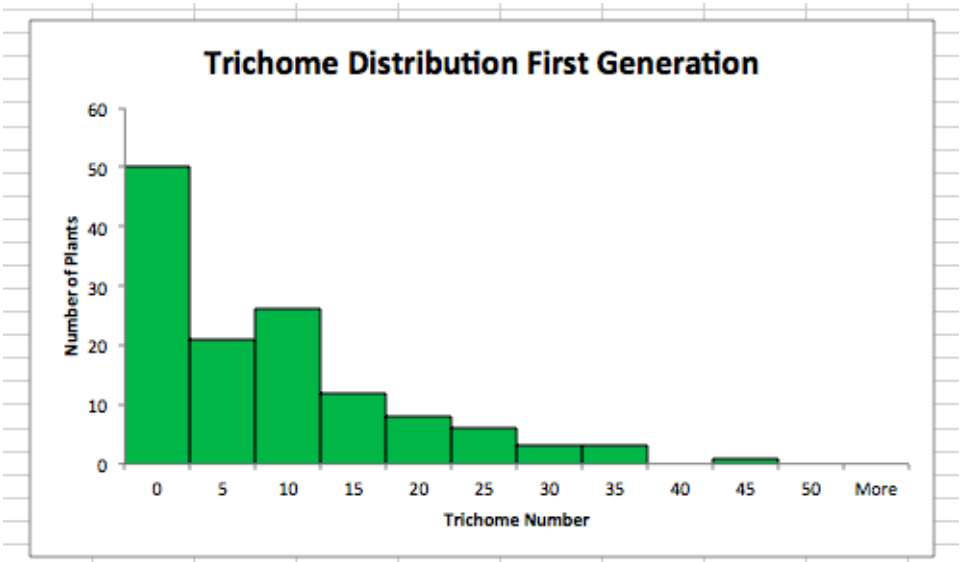

Frequency, Fitness
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0
10
20
30
40
50
60
70
80
90
100
Generation
10
1
N
p, Pop. 1
p, Pop. 2
p, Pop. 3
H, Pop. 1
H, Pop. 2
H, Pop. 3
Wavg, Pop. 1
Wavg, Pop. 2
Wavg., Pop. 3

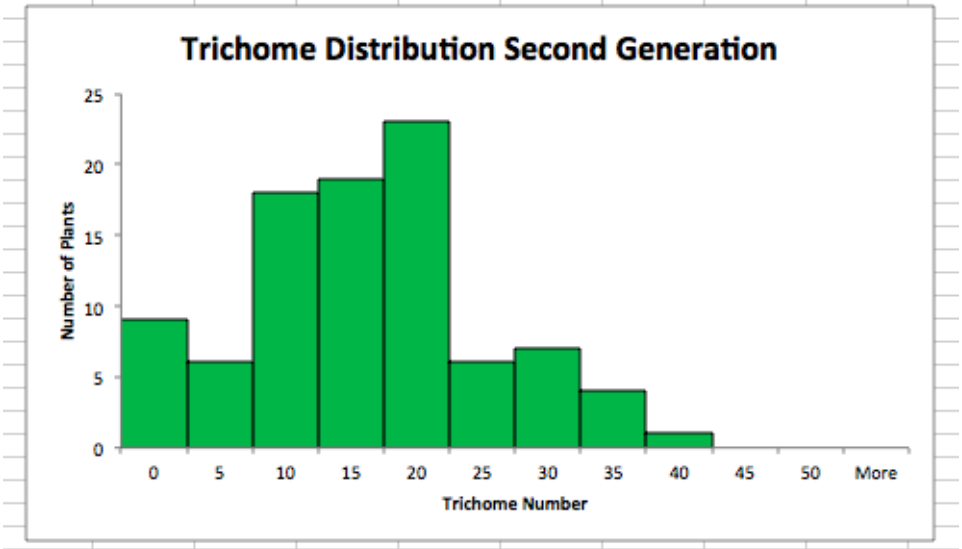
Lab Investigation Chapter
Big Idea 1: Evolution

Investigation Title: Artificial Selection in Wisconsin Fast Plants

Overview

- This investigation engages the entire class as a seed company that is assigned the task of creating a hairy strain of Fast Plants
- During guiding part of investigation students begin by planting and growing a population of Fast Plants.
- At about 7 days, teacher guides class into investigating normal variation found in the population of plants. Various traits are explored.
- Exploration of variation introduces descriptive statistical techniques
- Through questioning the teacher challenges the class to develop a procedure to create a new line of hairy plants
- Through discussion, the class arrives at consensus on the procedure to select for hairy plants based on the variability data collected earlier
- Ultimately, in small groups students will explore the possibility of phenotypic plasticity vs. inherited traits and relate all to artificial selection and evolution


Trichome Distribution First Generation
Number of Plants
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
45
50
More
Trichome Number


Trichome Distribution Second Generation
Number of Plants
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
45
50
More
Trichome Number

Any Questions