Assessing the initial state of knowledge of first-year genetics students

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Motivation

No standard inventory of conceptual understanding in the biological sciences.

Inventories in other disciplines have helped motivate the need for reform in undergraduate science education (*e.g.*, Force Concept Inventory, Astronomy Diagnostic Test, Conceptual Chemistry Test).

More vocabulary in introductory biology than in foreign language courses (Yager 1983).

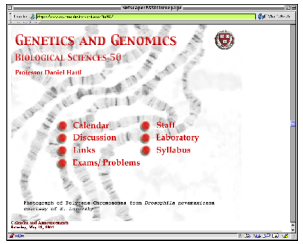
Students find that they can get by with memorization of definitions and little understanding of the underlying concepts.

Exams in introductory science courses tend not to test conceptual understanding and rarely ask open-ended questions.

R.E. Yager. 1983. *J. Res. Sci. Teach.* 20: 577-588.

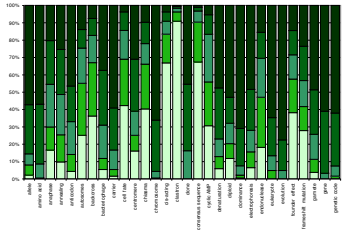
Genetics & Genomics

First semester for a new introductory genetics course for all students majoring in biology or biochemical sciences.and prerequisite for higher-level biology courses.

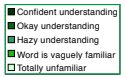


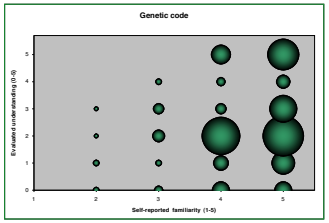
- 75% first-year students
- 73% pre-med
- 61% female
- 56% have taken AP (mean score: 4.7)
- 1st or 2nd college science course for 74%

Results

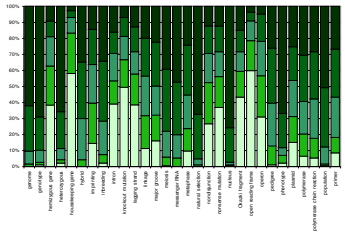


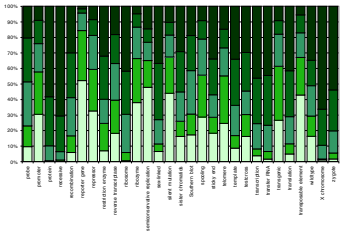
Students have a wide variety of backgrounds. Familiarity with terminology distributed among the class.



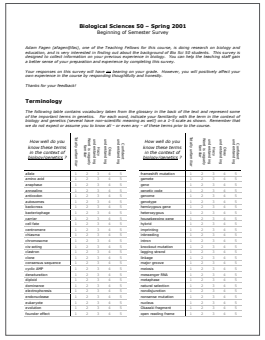


Not always a clear correspondence between students' familiarity with terminology and their actual understanding.





Survey instrument



Biological Sciences 50 – Spring 2001
Beginning of Semester Survey

Adam Fagen (afagen@fas), one of the Teaching Fellows for this course, is doing research on biology and genetics education and would like your participation in this survey. The purpose of this survey is to gather data designed to collect information on your previous experience in biology. You can help the teaching staff get a better sense of your preparation and experience by completing this survey.

Your responses on this survey will have no bearing on your grade. However, you will positively affect your own experience in the course by responding thoughtfully and honestly.

Thanks for your feedback!

Terminology

The following table contains vocabulary taken from the glossary in the back of the text and represent some of the important terms in genetics. For each word, indicate your familiarity with the term in the context of genetics and briefly define the term in the context of genetics. Do not guess at the definition. Remember that we do not expect or assume you to know all – or even any – of these terms prior to the course.

How well do you know these terms in the context of BIOLOGICAL GENETICS?	I do not know this	I have heard of it but can't define it	I can define it	I know it well	How well do you know these terms in the context of BIOLOGICAL GENETICS?	I do not know this	I have heard of it but can't define it	I can define it	I know it well
allele	1	2	3	4	transmitted mutation	1	2	3	4
amino acid	1	2	3	4	genome	1	2	3	4
anaphase	1	2	3	4	gene	1	2	3	4
antibiotic	1	2	3	4	genetic code	1	2	3	4
antibodies	1	2	3	4	genomic	1	2	3	4
autosomes	1	2	3	4	genotype	1	2	3	4
bacteria	1	2	3	4	hemizygous gene	1	2	3	4
bacteriophage	1	2	3	4	heterozygous	1	2	3	4
base pair	1	2	3	4	homologous chromosome	1	2	3	4
cell fate	1	2	3	4	hybrid	1	2	3	4
centromere	1	2	3	4	imprinting	1	2	3	4
chiasma	1	2	3	4	inbreeding	1	2	3	4
chromosome	1	2	3	4	intron	1	2	3	4
cleavage	1	2	3	4	knocked mutation	1	2	3	4
clastron	1	2	3	4	lagging strand	1	2	3	4
clone	1	2	3	4	linkage	1	2	3	4
conserve sequence	1	2	3	4	major groove	1	2	3	4
cycle 20P	1	2	3	4	meiosis	1	2	3	4
cytokinesis	1	2	3	4	messenger RNA	1	2	3	4
digest	1	2	3	4	metaphase	1	2	3	4
dominance	1	2	3	4	natural selection	1	2	3	4
electrophoresis	1	2	3	4	neutralization	1	2	3	4
endonuclease	1	2	3	4	nonsense mutation	1	2	3	4
enzyme	1	2	3	4	nucleotide	1	2	3	4
evolution	1	2	3	4	Okazaki fragment	1	2	3	4
founder effect	1	2	3	4	open reading frame	1	2	3	4

Familiarity with terminology

Rate familiarity with 87 common terms in genetics from glossary of text and two distractors ("clastron" and "spooling") on a 1-5 point scale:

5 = Confident understanding
4 = Okay understanding
3 = Hazy understanding
2 = Word is vaguely familiar
1 = Totally unfamiliar

Definitions

Briefly define 18 terms on vocabulary list (including distractor "spooling")

Concept questions

One multiple choice, one free response, and one three-part data interpretation question.

Background information

High school and college science coursework, previous experience in biology, expected major, demographic information

Post-test

At the end of the semester, a similar survey was administered to assess learning gains about the courses.

Students show much greater familiarity with vocabulary and increased ability to define terms.

Students still hold misconceptions about the nature of genetic material (>10% do not report that genetic material is identical between cells).

Future work

Complete analysis of aggregate post-test results.

Compare pre- and post-test responses for individual students.

Investigate correlations between survey responses, educational background, and class performance.

Use results to inform the development of a conceptual inventory which diminishes the impact of vocabulary.

Acknowledgements

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