Developing Quantitative Skills in Your Courses Using HHMI BioInteractive Resources

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Welcome!

Label your sticker with the course(s) you teach:
BIO, MICRO, A&P, other (specify)

Discuss with your table:

1. What is your biggest strength as a professor?
2. What is your biggest challenge in your courses?

Workshop Agenda

- Introductions
- Importance of teaching quantitative skills
- Overview and exploration of HHMI resources
- Examples from our classrooms
- Assessment activity
- Implementation: What will you take home to your classrooms?

Workshop Goals

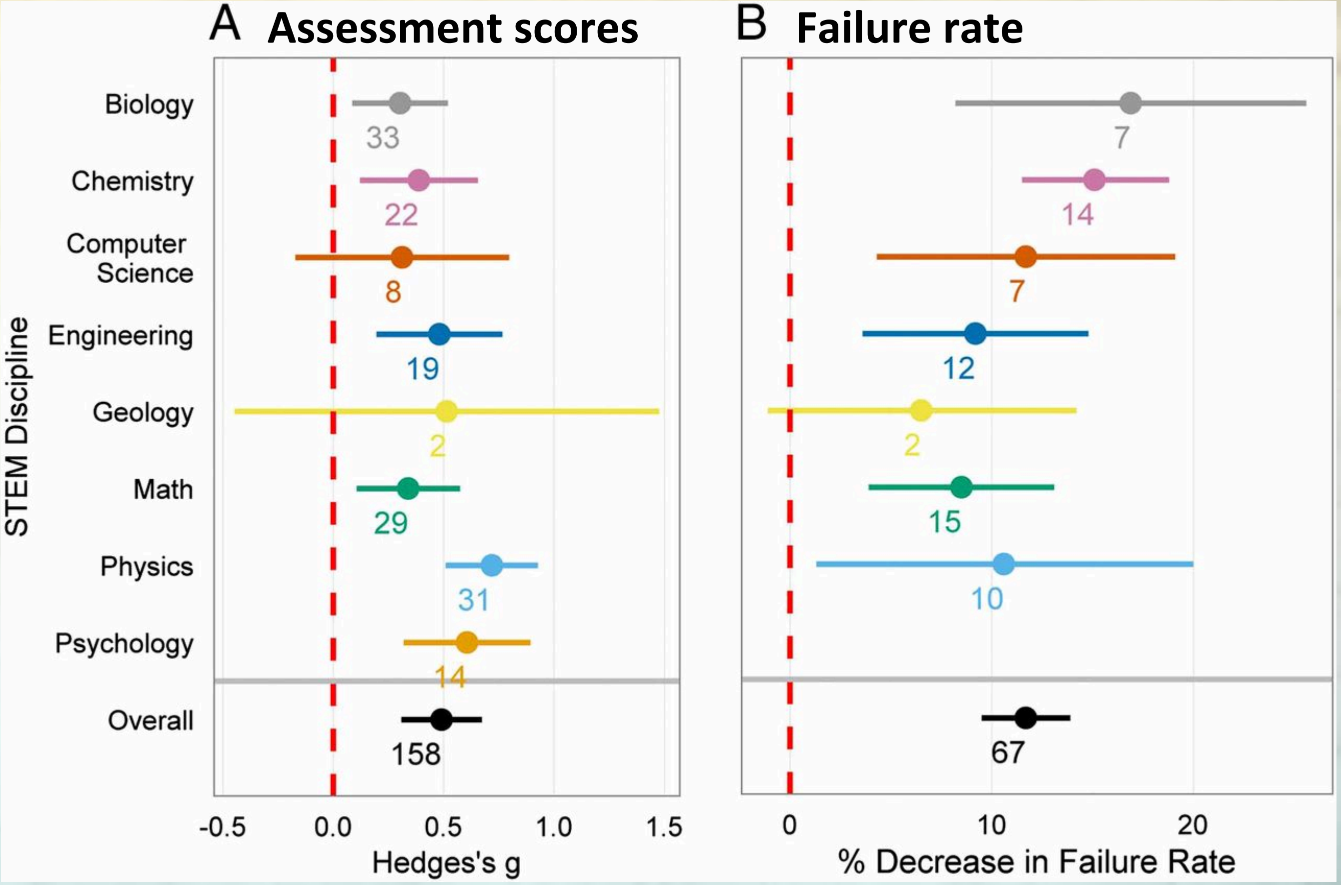
- To understand quantitative literacy as part of the Call to Action
- To become familiar with the HHMI website and available resources
- To learn about modifying, scaffolding, and supplementing of HHMI and partner resources for your classroom
- To participate in an active assessment strategy of quantitative skills
- To explore development and modification of HHMI resources in your own classroom

Summarize this figure

Effect size of active learning by discipline

Horizontal lines show 95% confidence interval

Numbers indicate the number of independent studies included in meta analysis



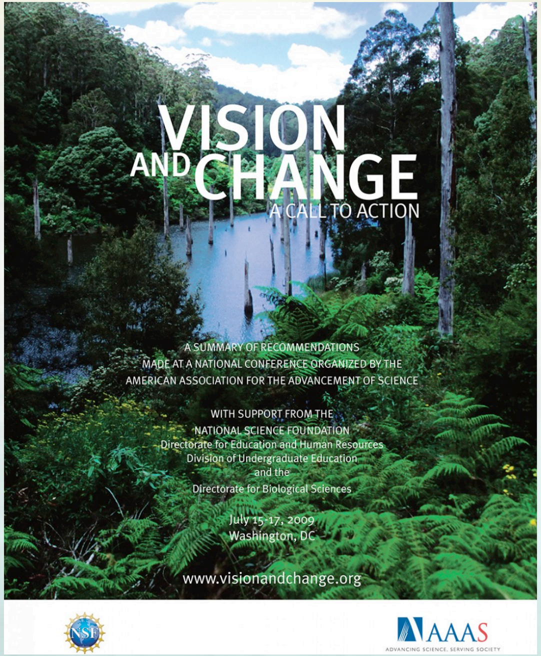
Scott Freeman et al. PNAS 2014;111:8410-8415

Benefits of active learning

Which of the following are important to you?

“Relate concepts to real-world examples”
“Develop lifelong science-learning competencies”
“Introduce fewer concepts in greater depth”
“Stimulate the curiosity of students”
“Demonstrate the passion scientists have for their discipline”
“Engage students as active participants”
“Use multiple modes of instruction”
“…active, outcome oriented, inquiry-driven and relevant.”

Vision and Change



VISION AND CHANGE

A CALL TO ACTION

A SUMMARY OF RECOMMENDATIONS
MADE AT A NATIONAL CONFERENCE ORGANIZED BY THE
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

WITH SUPPORT FROM THE
NATIONAL SCIENCE FOUNDATION
Directorate for Education and Human Resources
Division of Undergraduate Education
and the
Directorate for Biological Sciences

July 15-17, 2009
Washington, DC

www.visionandchange.org

NSF

AAAS
ADVANCING SCIENCE, SERVING SOCIETY

NSF "Vision and Change" identifies quantitative reasoning as a core competency

Students need quantitative skills…

Now: inability to transfer and apply skills between math and science courses (Brent 2004, Gross 2004, Hoy 2004)

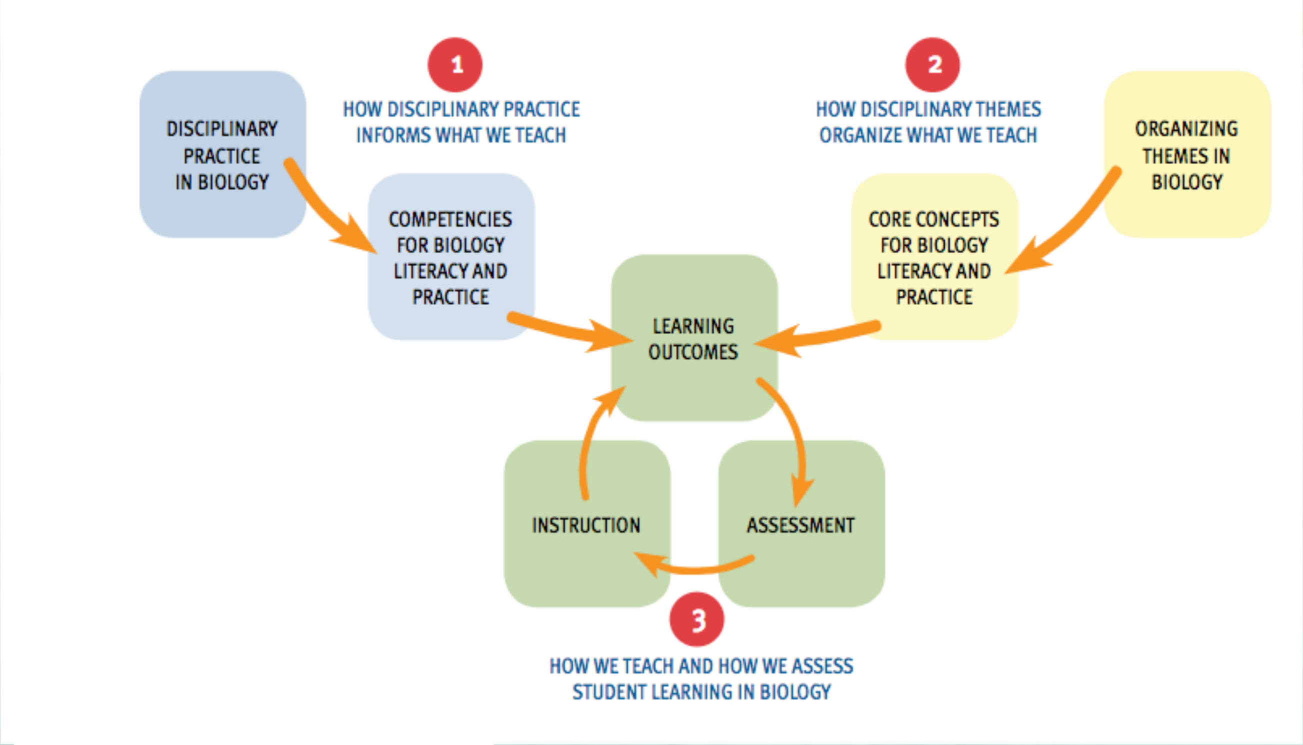
In the near future: standardized tests (GRE, MCAT) now assess quantitative reasoning because of its importance in graduate school (Barraquand et al 2014) and medical school (AAMC/HHMI 2009)

In their careers: "omics" era is quantitative and interdisciplinary; lack of quantitative skills is impeding advances in research (Chitnis and Smith 2012, Fawcett and Higginson 2012, Fernandes 2012)

Brainstorm Activity:
Which quantitative skills are important in your classroom?

- Quantitative reasoning applied to biological teaching practice:
  - Evaluate and interpret data
  - Developing and interpreting graphs
  - Applying statistical methods to diverse data
    - Calculate descriptive statistics
    - Conduct inferential statistical tests
    - Interpret statistical significance
  - Mathematical modeling
  - Managing and analyzing large data sets

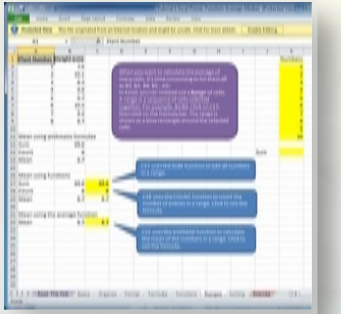
How Should We Approach Design of Biology Curricula?


1
HOW DISCIPLINARY PRACTICE INFORMS WHAT WE TEACH
2
HOW DISCIPLINARY THEMES ORGANIZE WHAT WE TEACH
DISCIPLINARY PRACTICE IN BIOLOGY
COMPETENCIES FOR BIOLOGY LITERACY AND PRACTICE
ORGANIZING THEMES IN BIOLOGY
CORE CONCEPTS FOR BIOLOGY LITERACY AND PRACTICE
LEARNING OUTCOMES
INSTRUCTION
ASSESSMENT
3
HOW WE TEACH AND HOW WE ASSESS STUDENT LEARNING IN BIOLOGY

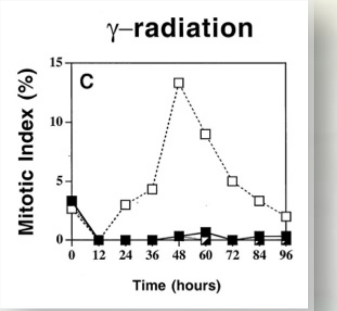
Vision and Change 2011 Report

Why we like HHMI BioInteractive

Short Courses



Data Points

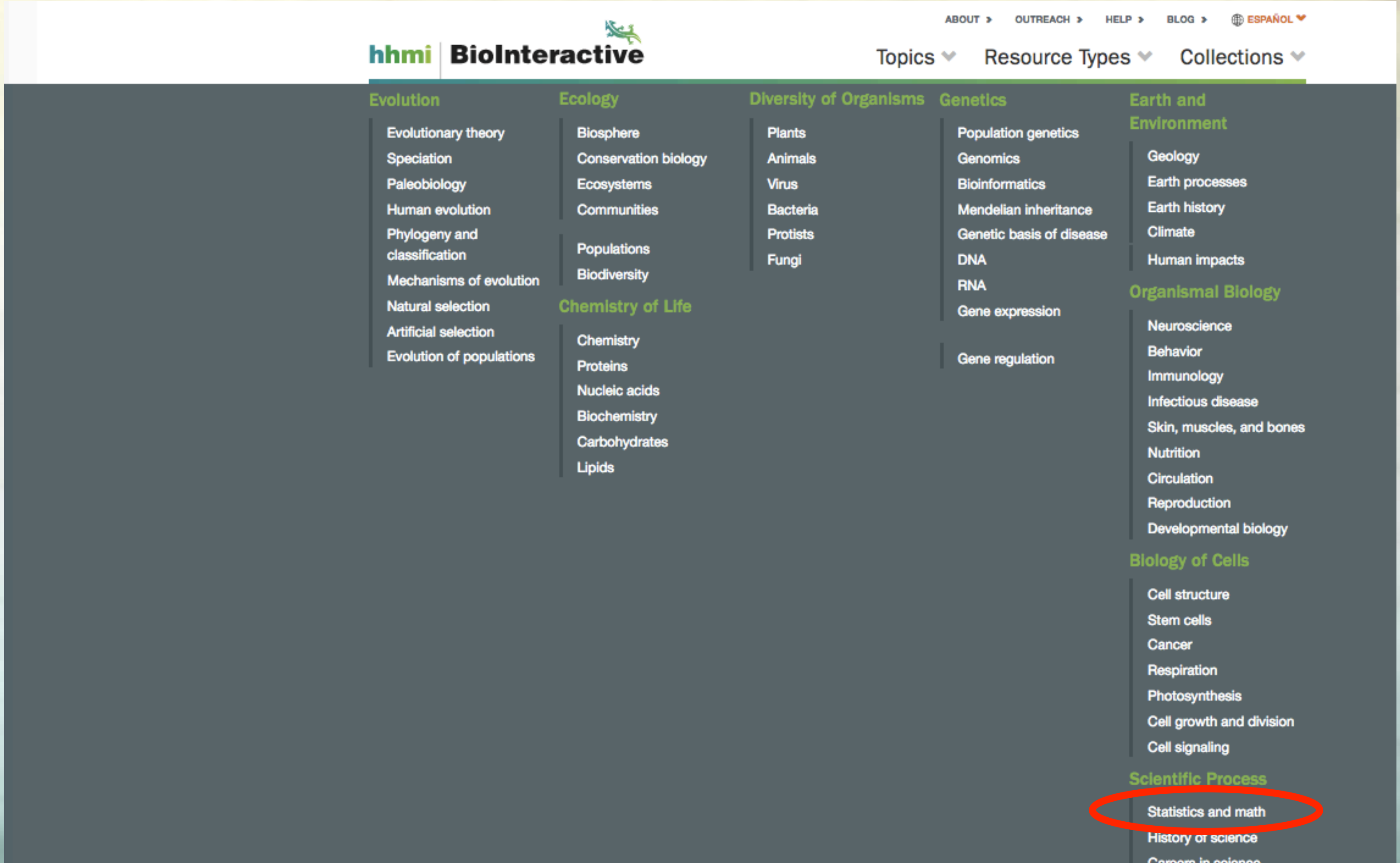


Scientists at Work

Virtual Labs

- Free and accessible
- Clear, polished, entertaining
- Focused on active learning and engagement
- Use of real data and real scientists
- Diversity of resources

Topics on BioInteractive



Evolution

- Evolutionary theory
- Speciation
- Paleobiology
- Human evolution
- Phylogeny and classification
- Mechanisms of evolution
- Natural selection
- Artificial selection
- Evolution of populations

Ecology

- Biosphere
- Conservation biology
- Ecosystems
- Communities
- Populations
- Biodiversity

Chemistry of Life

- Chemistry
- Proteins
- Nucleic acids
- Biochemistry
- Carbohydrates
- Lipids

Diversity of Organisms

- Plants
- Animals
- Virus
- Bacteria
- Protists
- Fungi

Genetics

- Population genetics
- Genomics
- Bioinformatics
- Mendelian inheritance
- Genetic basis of disease
- DNA
- RNA
- Gene expression
- Gene regulation

Earth and Environment

- Geology
- Earth processes
- Earth history
- Climate
- Human impacts

Organismal Biology

- Neuroscience
- Behavior
- Immunology
- Infectious disease
- Skin, muscles, and bones
- Nutrition
- Circulation
- Reproduction
- Developmental biology

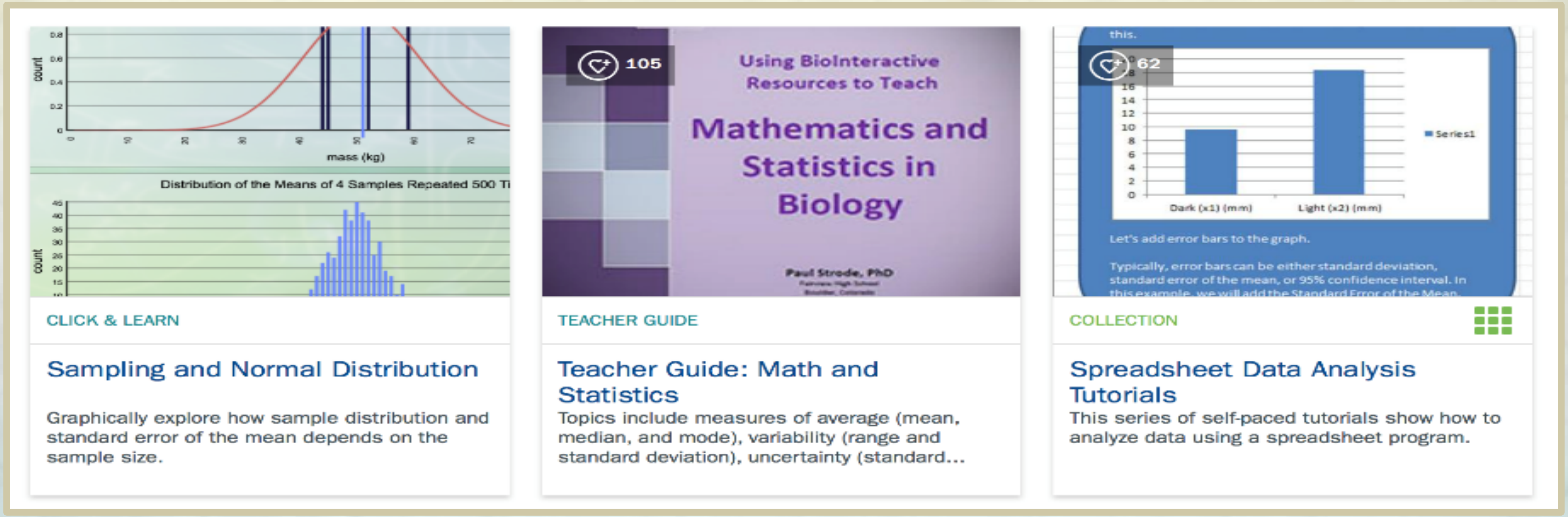
Biology of Cells

- Cell structure
- Stem cells
- Cancer
- Respiration
- Photosynthesis
- Cell growth and division
- Cell signaling

Scientific Process

- Statistics and math
- History of science
- Careers in science

Working with Data


count
mass (kg)
Distribution of the Means of 4 Samples Repeated 500 Ti
105
Using BioInteractive Resources to Teach
Mathematics and Statistics in Biology
Paul Strode, PhD
62
Series1
Dark (x1) (mm)
Light (x2) (mm)
Let's add error bars to the graph.
Typically, error bars can be either standard deviation, standard error of the mean, or 95% confidence interval. In

CLICK & LEARN

Sampling and Normal Distribution

Graphically explore how sample distribution and standard error of the mean depends on the sample size.

TEACHER GUIDE

Teacher Guide: Math and Statistics

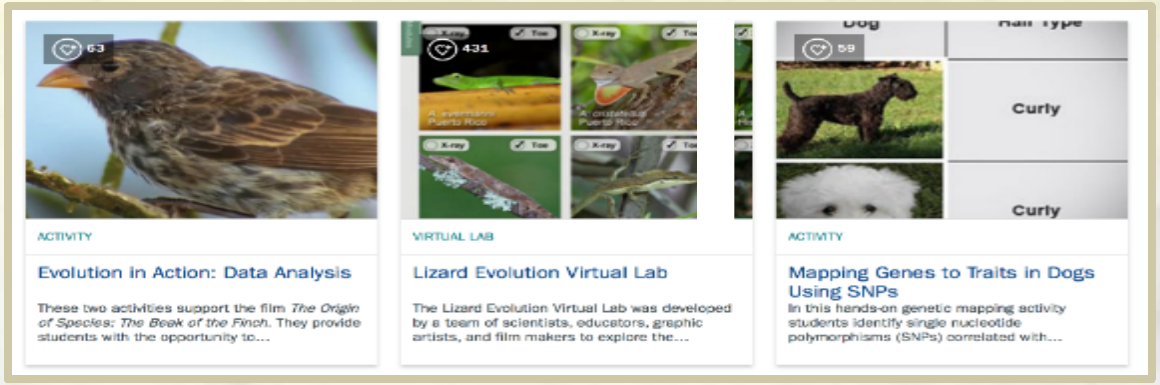
Topics include measures of average (mean, median, and mode), variability (range and standard deviation), uncertainty (standard...

COLLECTION

Spreadsheet Data Analysis Tutorials

This series of self-paced tutorials show how to analyze data using a spreadsheet program.

Working with Data



ACTIVITY

Evolution in Action: Data Analysis

These two activities support the film *The Origin of Species: The Beak of the Finch*. They provide students with the opportunity to...

VIRTUAL LAB

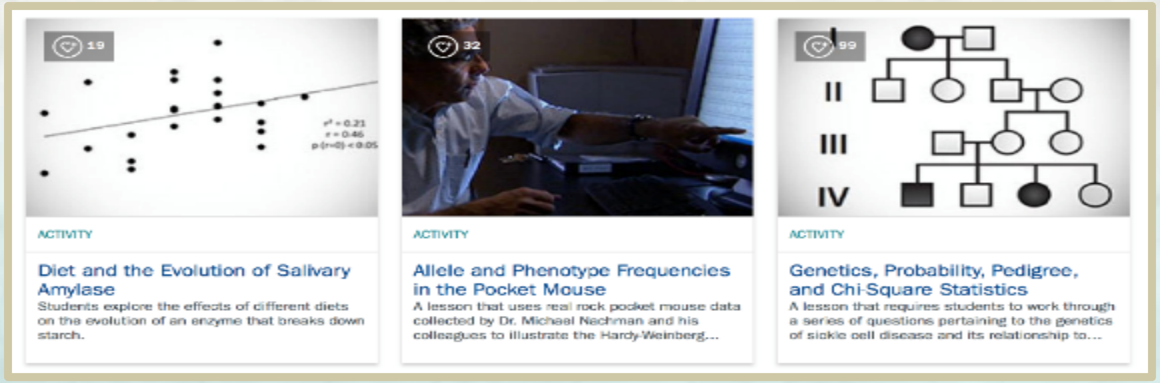
Lizard Evolution Virtual Lab

The Lizard Evolution Virtual Lab was developed by a team of scientists, educators, graphic artists, and film makers to explore the...

ACTIVITY

Mapping Genes to Traits in Dogs Using SNPs

In this hands-on genetic mapping activity students identify single nucleotide polymorphisms (SNPs) correlated with...



ACTIVITY

Diet and the Evolution of Salivary Amylase

Students explore the effects of different diets on the evolution of an enzyme that breaks down starch.

ACTIVITY

Allele and Phenotype Frequencies in the Pocket Mouse

A lesson that uses real rock pocket mouse data collected by Dr. Michael Nachman and his colleagues to illustrate the Hardy-Weinberg...

ACTIVITY

Genetics, Probability, Pedigree, and Chi-Square Statistics

A lesson that requires students to work through a series of questions pertaining to the genetics of sickle cell disease and its relationship to...

Links with Annotated Science Papers

Science in the Classroom AAAS

Annotated research papers and accompanying teaching materials

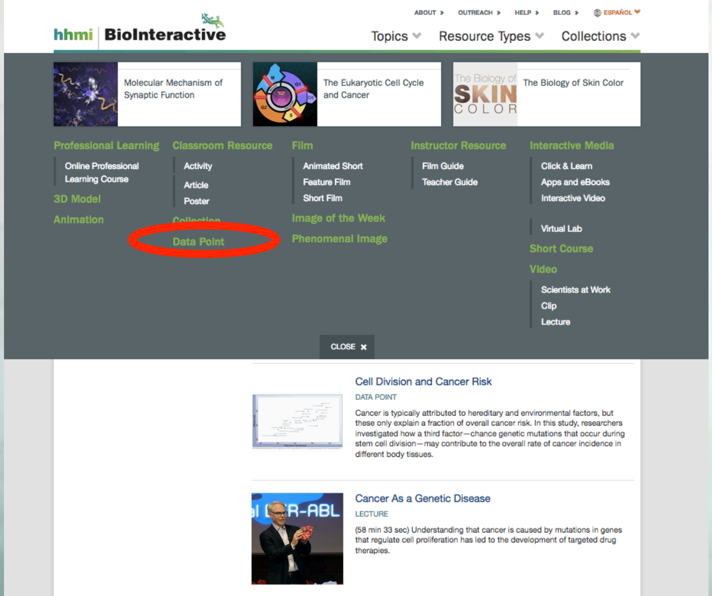
- http://www.scienceintheclassroom.org/
  - Papers published in the journal Science with a rich library of supporting information
  - How many of you are familiar this resource?

Links with Annotated Science Papers

Science in the Classroom AAAS

Annotated research papers and accompanying teaching materials

- Does bad luck cause cancer?



Cell Division and Cancer Risk

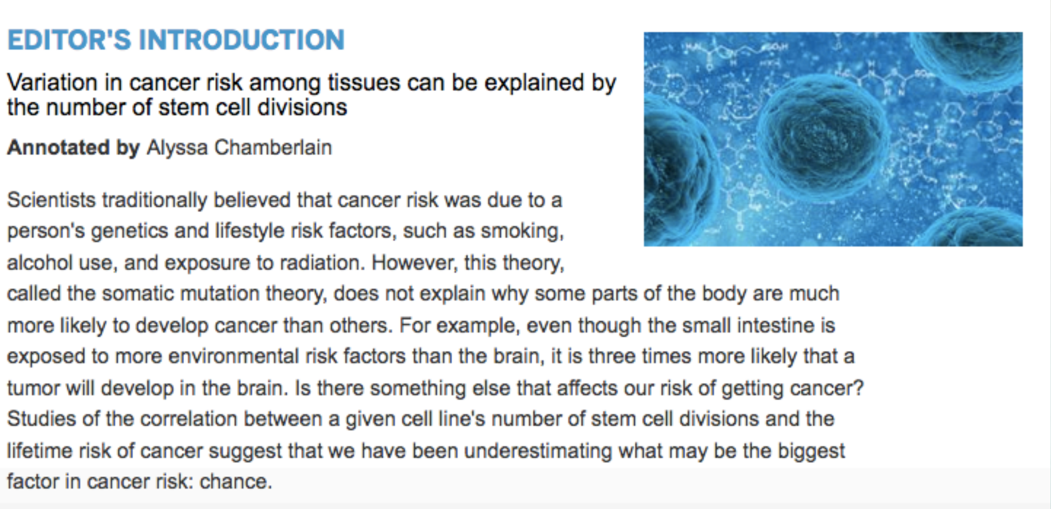
DATA POINT

Cancer is typically attributed to hereditary and environmental factors, but these only explain a fraction of overall cancer risk. In this study, researchers investigated how a third factor—chance genetic mutations that occur during stem cell division—may contribute to the overall rate of cancer incidence in different body tissues.

Cancer As a Genetic Disease

LECTURE

(58 min 33 sec) Understanding that cancer is caused by mutations in genes that regulate cell proliferation has led to the development of targeted drug therapies.



EDITOR'S INTRODUCTION

Variation in cancer risk among tissues can be explained by the number of stem cell divisions

Annotated by Alyssa Chamberlain

Scientists traditionally believed that cancer risk was due to a person's genetics and lifestyle risk factors, such as smoking, alcohol use, and exposure to radiation. However, this theory, called the somatic mutation theory, does not explain why some parts of the body are much more likely to develop cancer than others. For example, even though the small intestine is exposed to more environmental risk factors than the brain, it is three times more likely that a tumor will develop in the brain. Is there something else that affects our risk of getting cancer? Studies of the correlation between a given cell line's number of stem cell divisions and the lifetime risk of cancer suggest that we have been underestimating what may be the biggest factor in cancer risk: chance.

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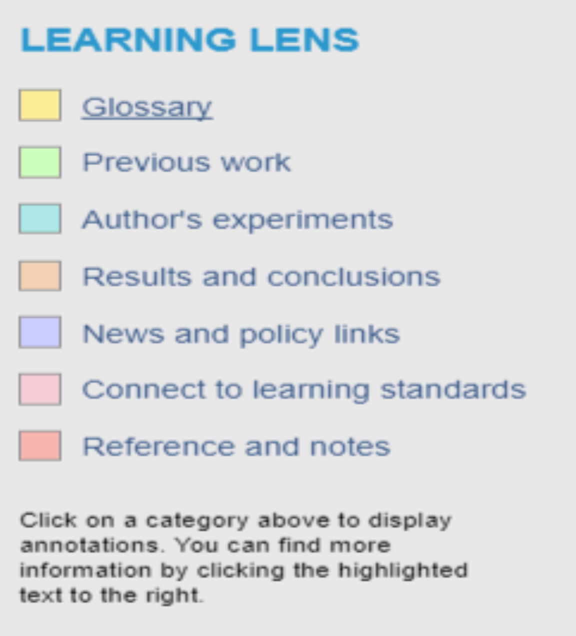
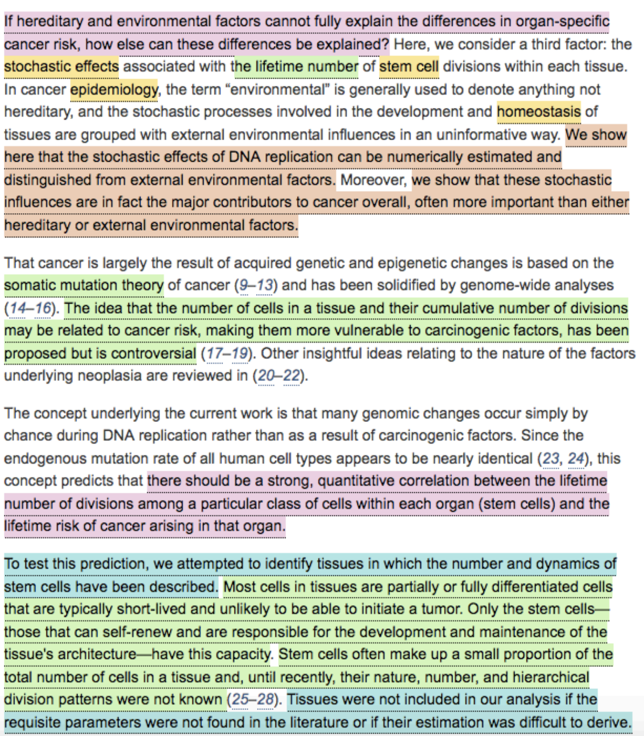
Links with Annotated Science Papers



LEARNING LENS

- 🟨 Glossary
- 🟩 Previous work
- 🟦 Author's experiments
- 🟧 Results and conclusions
- 🟪 News and policy links
- ▨ Connect to learning standards
- 🟥 Reference and notes

Click on a category above to display annotations. You can find more information by clicking the highlighted text to the right.



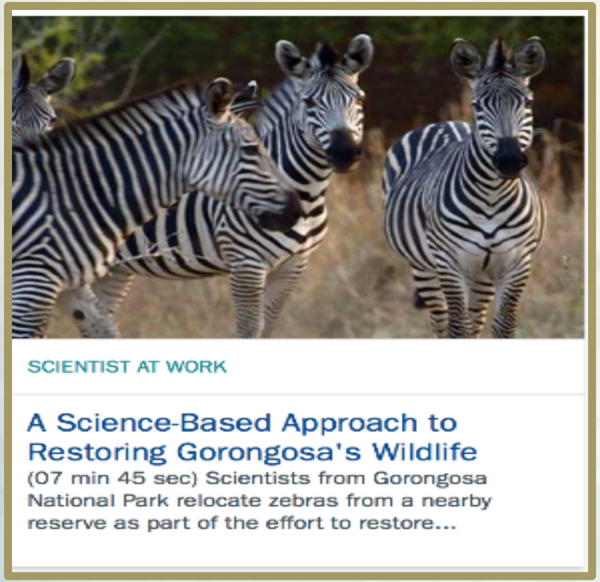
If hereditary and environmental factors cannot fully explain the differences in organ-specific cancer risk, how else can these differences be explained? Here, we consider a third factor: the stochastic effects associated with the lifetime number of stem cell divisions within each tissue. In cancer epidemiology, the term "environmental" is generally used to denote anything not hereditary, and the stochastic processes involved in the development and homeostasis of tissues are grouped with external environmental influences in an uninformative way. We show here that the stochastic effects of DNA replication can be numerically estimated and distinguished from external environmental factors. Moreover, we show that these stochastic influences are in fact the major contributors to cancer overall, often more important than either hereditary or external environmental factors.

That cancer is largely the result of acquired genetic and epigenetic changes is based on the somatic mutation theory of cancer (*9*–*13*) and has been solidified by genome-wide analyses (*14*–*16*). The idea that the number of cells in a tissue and their cumulative number of divisions may be related to cancer risk, making them more vulnerable to carcinogenic factors, has been proposed but is controversial (*17*–*19*). Other insightful ideas relating to the nature of the factors underlying neoplasia are reviewed in (*20*–*22*).

The concept underlying the current work is that many genomic changes occur simply by chance during DNA replication rather than as a result of carcinogenic factors. Since the endogenous mutation rate of all human cell types appears to be nearly identical (*23*, *24*), this concept predicts that there should be a strong, quantitative correlation between the lifetime number of divisions among a particular class of cells within each organ (stem cells) and the lifetime risk of cancer arising in that organ.

To test this prediction, we attempted to identify tissues in which the number and dynamics of stem cells have been described. Most cells in tissues are partially or fully differentiated cells that are typically short-lived and unlikely to be able to initiate a tumor. Only the stem cells—those that can self-renew and are responsible for the development and maintenance of the tissue's architecture—have this capacity. Stem cells often make up a small proportion of the total number of cells in a tissue and, until recently, their nature, number, and hierarchical division patterns were not known (*25*–*28*). Tissues were not included in our analysis if the requisite parameters were not found in the literature or if their estimation was difficult to derive.

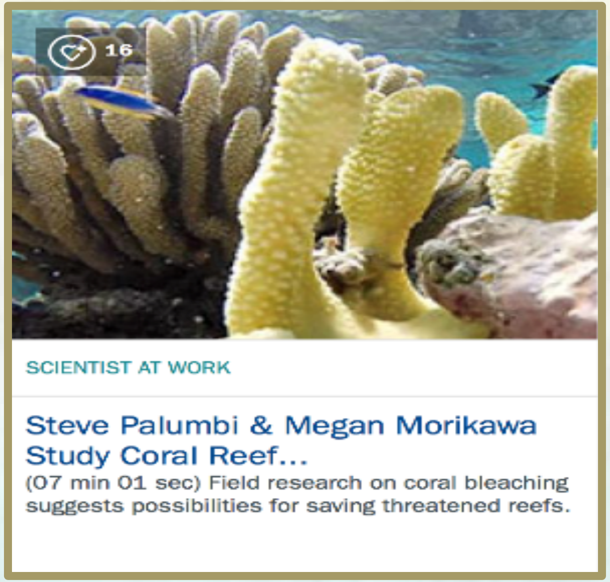
Scientist at Work



SCIENTIST AT WORK

A Science-Based Approach to Restoring Gorongosa's Wildlife

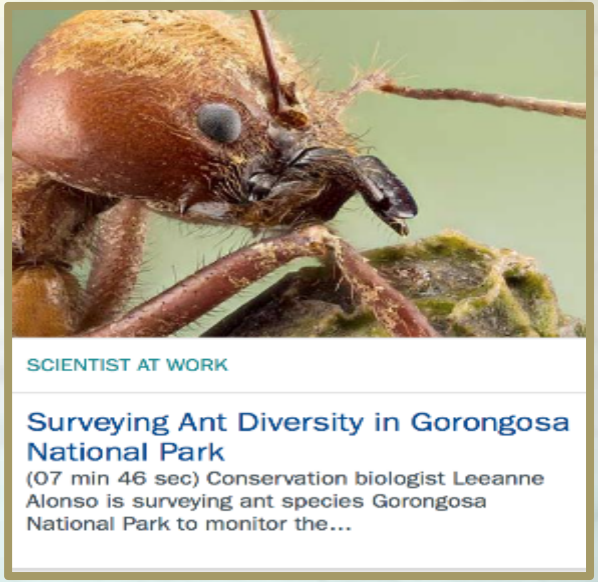
(07 min 45 sec) Scientists from Gorongosa National Park relocate zebras from a nearby reserve as part of the effort to restore...



SCIENTIST AT WORK

Steve Palumbi & Megan Morikawa Study Coral Reef...

(07 min 01 sec) Field research on coral bleaching suggests possibilities for saving threatened reefs.



SCIENTIST AT WORK

Surveying Ant Diversity in Gorongosa National Park

(07 min 46 sec) Conservation biologist Leeanne Alonso is surveying ant species Gorongosa National Park to monitor the...

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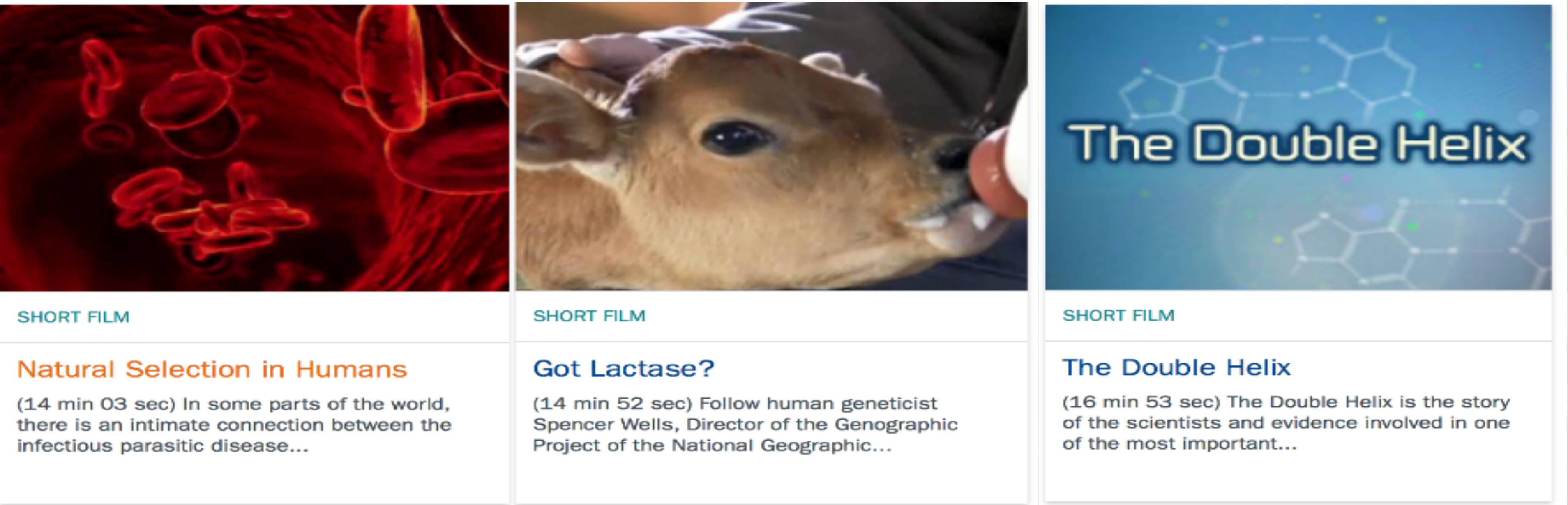
Short Films



SHORT FILM

Natural Selection in Humans

(14 min 03 sec) In some parts of the world, there is an intimate connection between the infectious parasitic disease...

SHORT FILM

Got Lactase?

(14 min 52 sec) Follow human geneticist Spencer Wells, Director of the Genographic Project of the National Geographic...

SHORT FILM

The Double Helix

(16 min 53 sec) The Double Helix is the story of the scientists and evidence involved in one of the most important...

Embrace the power of the story to motivate students to dive into the data

Scavenger Hunt Activity

- Select a resource type you'd like to explore further:
  1. Data Points
  2. Short Courses
  3. Activities
  4. Click and Learns
  5. Virtual Labs
  6. Science in the Classroom
- Use the worksheet to guide you through your chosen resource (15 min)
- Discuss your findings with your table (15 min)

How Can I Modify HHMI Resources?

- Deconstruct and scaffold to your learning outcomes and technology
- HHMI resources are best when modified for your learning environment
  - Addresses posted answer key concerns
- Use the references to locate original sources
- Bring in more data
  - Recognize data types
  - Recreate figures
  - Perform summary calculations
- Bring in more graphs
  - Identify components of figures
  - Connect research questions with data presentation and conclusions

Available Modified Activities

Quantitative Skills Workshop Resource Links
HHMI BioInteractive resources
0 likes 6 posts
Science in the Classroom Annotated Papers
Annotations include vocabulary, methods, descriptions of prior research, and explanations of major conclusions. Each paper has an educator's guide outlining connections to science competencies within STEM learning frameworks and standards, as well as suggested activities and resources for further
0 likes 7 posts
Scientists at Work
0 likes 1 posts
This is a collection of materials related to the
The Origin of Species
The Beak of the Finch
Lactase & Amylase
This is a collection of materials related to the
Got Lactase?
The Co-evolution of Genes and Culture
0 likes 8 posts
Dog Genome-Wide Association Study
produced by HHMI BioInteractive
Coral Bleaching
This is a collection of materials related to the
Resistance to Coral Bleaching
0 likes 10 posts
Cancer Genomics
Cancer Genomics module produced by HHMI
BioInteractive
hhmi BioInteractive
OVERVIEW OF CANCER DISCOVERY ACTIVITIES
EDUCATOR MATERIALS
0 likes 9 posts
Anole Selection Experiment
This is a collection of materials related to the
Anole Selection Experiment module produced

QUBES Hub

- Platform for collaboration and open sharing of quantitative teaching resources

https://qubeshub.org/groups/hhmibiointeractive/

- The original HHMI resource link plus modified educator resources are provided on this site

Examples of Modifying and Scaffolding Quantitative Skills in HHMI Resources

- Analyzing Data from a Viral Outbreak
- Interpreting and Troubleshooting ELISAs
- Amylase Copy Number and Diet using Spreadsheet Tutorials
- Calculating Lifetime Cancer Risk Resulting from DNA Replication

Analyzing Data from a Viral Outbreak: Scientists at Work

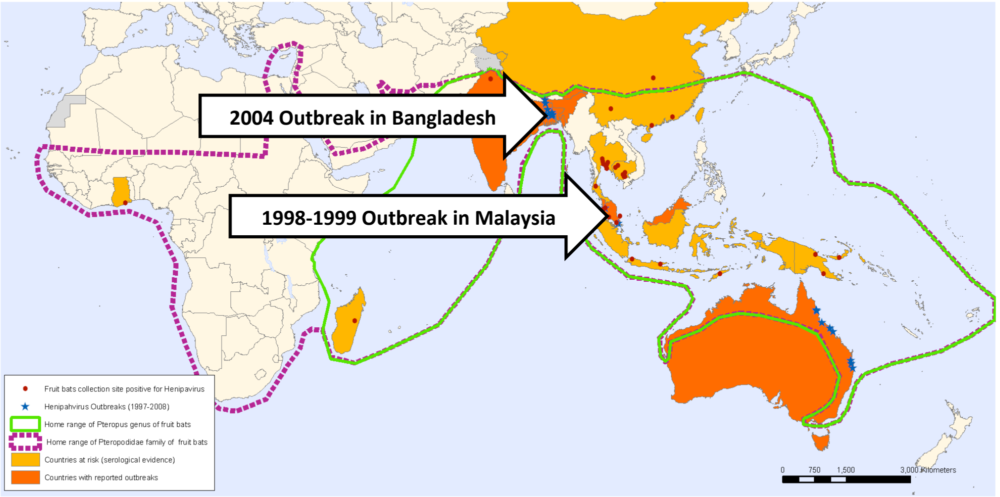
Analyzing Data from a Viral Outbreak

Interpret a data table

Calculate:

- Incidence
- Prevalence
- Morbidity
- Mortality
- Case Fatality Ratio
- R_0

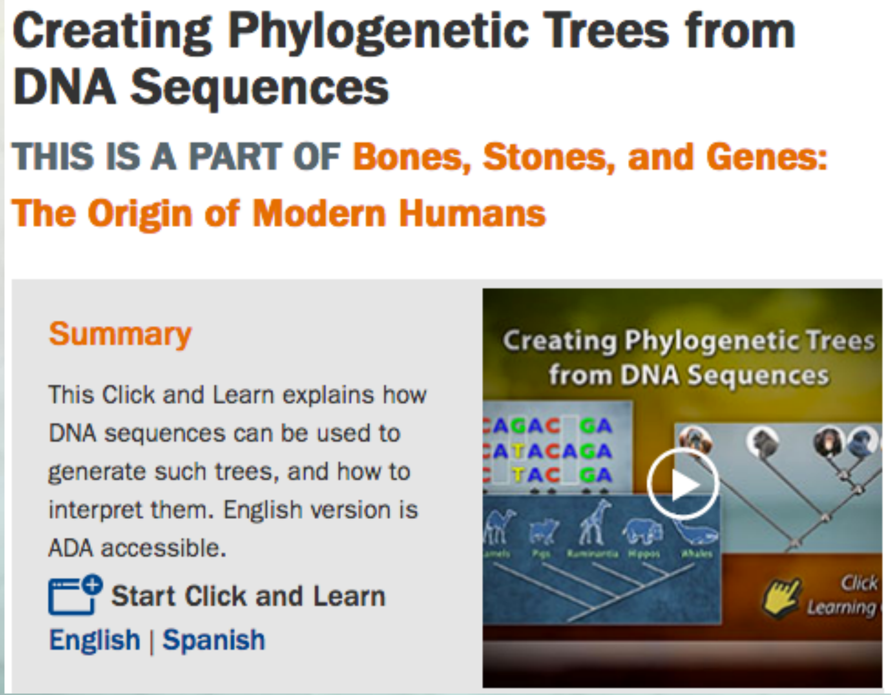
Geographic distribution of Henipavirus outbreaks and fruit bats of Pteropodidae Family


2004 Outbreak in Bangladesh
1998-1999 Outbreak in Malaysia
● Fruit bats collection site positive for Henipavirus
★ Henipahvirus Outbreaks (1997-2008)
Home range of Pteropus genus of fruit bats
Home range of Pteropodidae family of fruit bats
Countries at risk (serological evidence)
Countries with reported outbreaks
0
750
1,500
3,000 Kilometers

Data Source: Global Alert and Response Department
World Health Organization
Map Production: Public Health Information
and Geographic Information Systems (GIS)
World Health Organization

World Health Organization

Analyzing Data from a Viral Outbreak: Extension Activities



Creating Phylogenetic Trees from DNA Sequences

THIS IS A PART OF **Bones, Stones, and Genes: The Origin of Modern Humans**

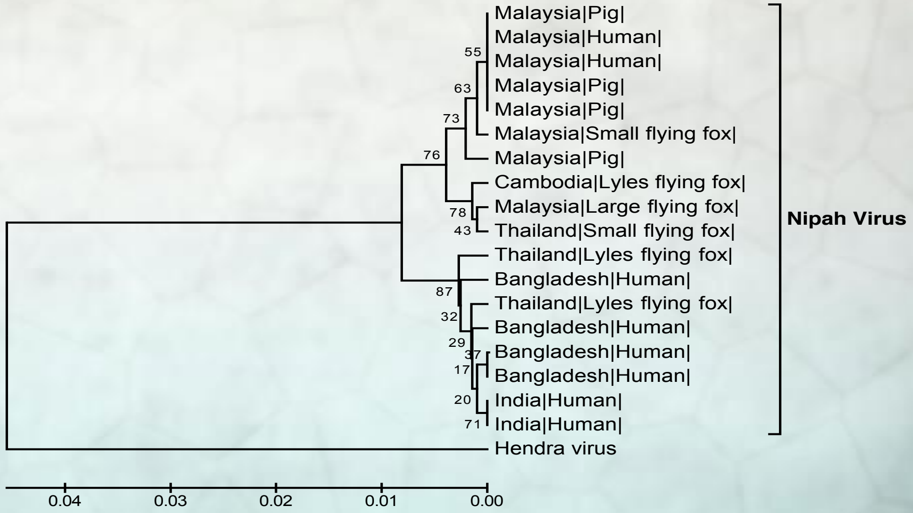
Summary

This Click and Learn explains how DNA sequences can be used to generate such trees, and how to interpret them. English version is ADA accessible.

Start Click and Learn

English | Spanish

https://qubeshub.org/groups/hhmibiointeractive/collections/all

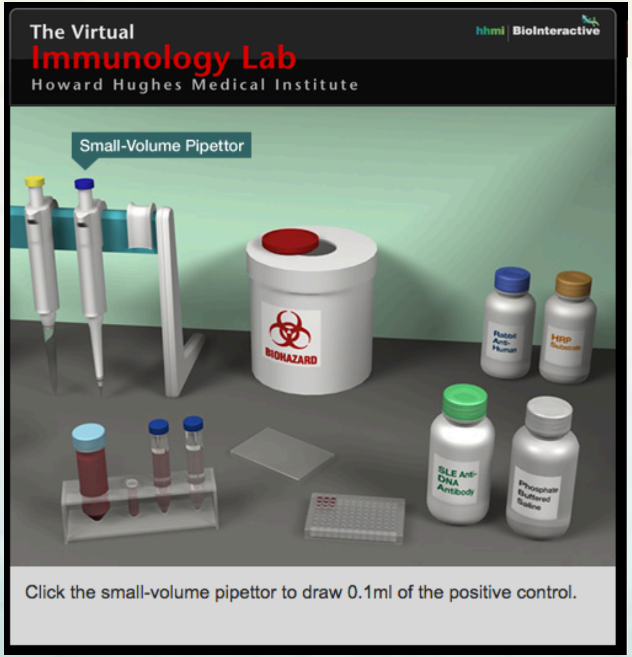


Analyzing Data from a Viral Outbreak: Learning Outcomes Addressed

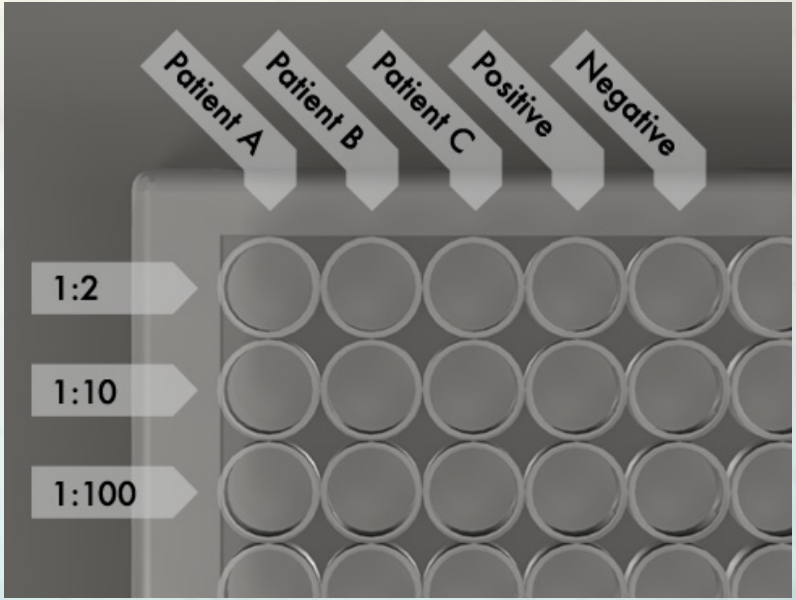
Students will be able to…

- Synthesize knowledge of antigens and antibodies with knowledge of enzymes to understand enzyme immunoassay technology.
- Distill complex, real-world data using basic calculations.
- Describe an outbreak of a disease using appropriate scientific terms, including “reservoir” and “spill over”.
- Discuss limitations in experimental design.

Interpreting and Troubleshooting ELISAs: Virtual Labs



Click the small-volume pipettor to draw 0.1ml of the positive control.



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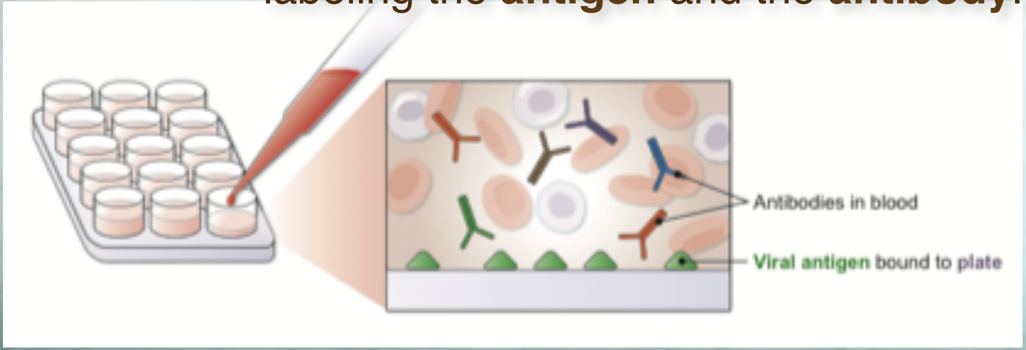
Interpreting and Troubleshooting ELISAs: Extension Activity

1. Explain how Dr. Epstein can use ELISAs to detect the presence of an active Nipah virus infection in bats.
    1. Draw a picture of the interactions that would occur molecularly in this ELISA, labeling the **antigen** and the **antibody**.
2. How might ELISAs be used to determine if a bat has *ever* been infected with Nipah virus?
    1. Draw a picture of the interactions that would occur molecularly in this ELISA, labeling the **antigen** and the **antibody**.



Interpreting and Troubleshooting ELISAs: Learning Outcomes Addressed

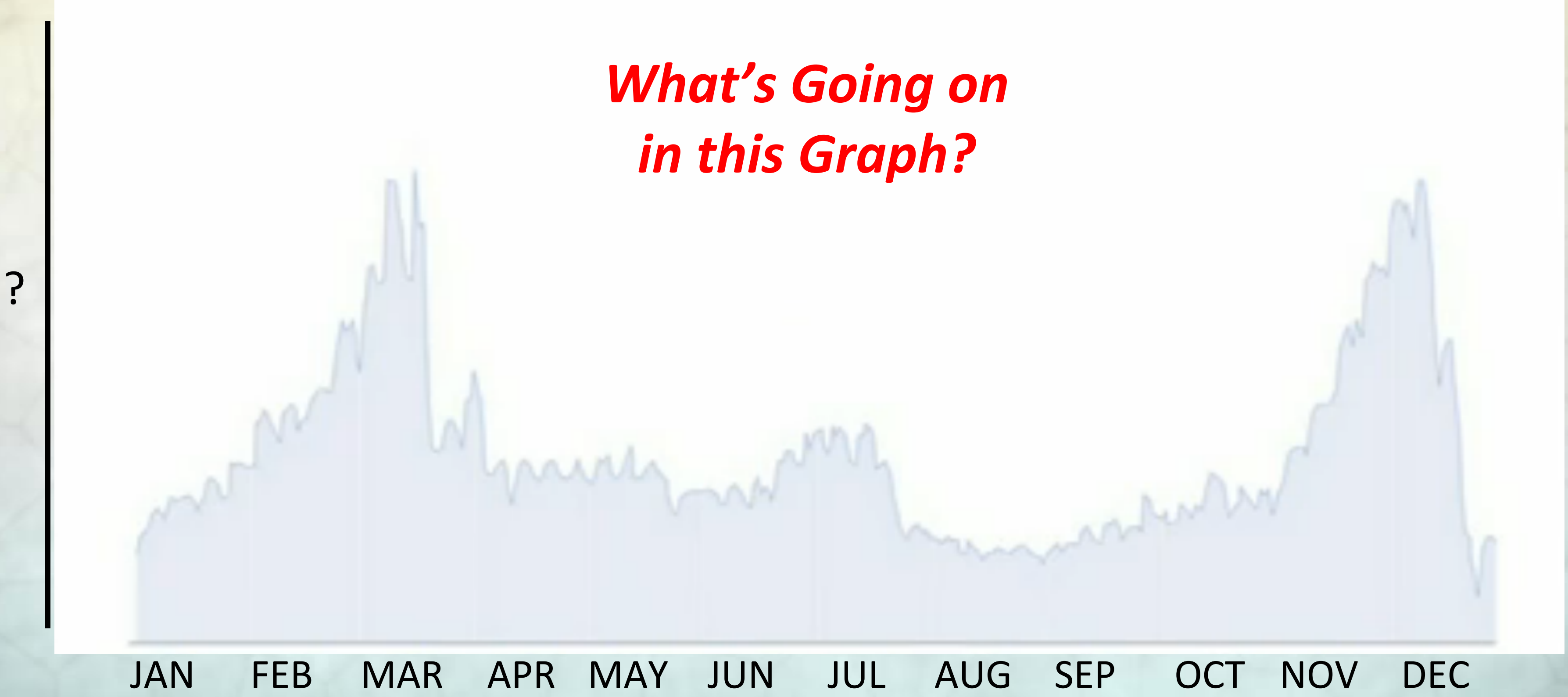
Students will be able to…

- **Synthesize knowledge of antigens and antibodies with knowledge of enzymes to understand enzyme immunoassay technology.**
- Distill complex, real-world data using basic calculations.
- Describe an outbreak of a disease using appropriate scientific terms, including “reservoir” and “spill over”.
- **Discuss limitations in experimental design.**

Lunch

- Think about a learning outcome in your course that could integrate more quantitative reasoning or a quantitative skill that needs development.
- Identify potential collaborators for this afternoon's activity

Figure of the Day



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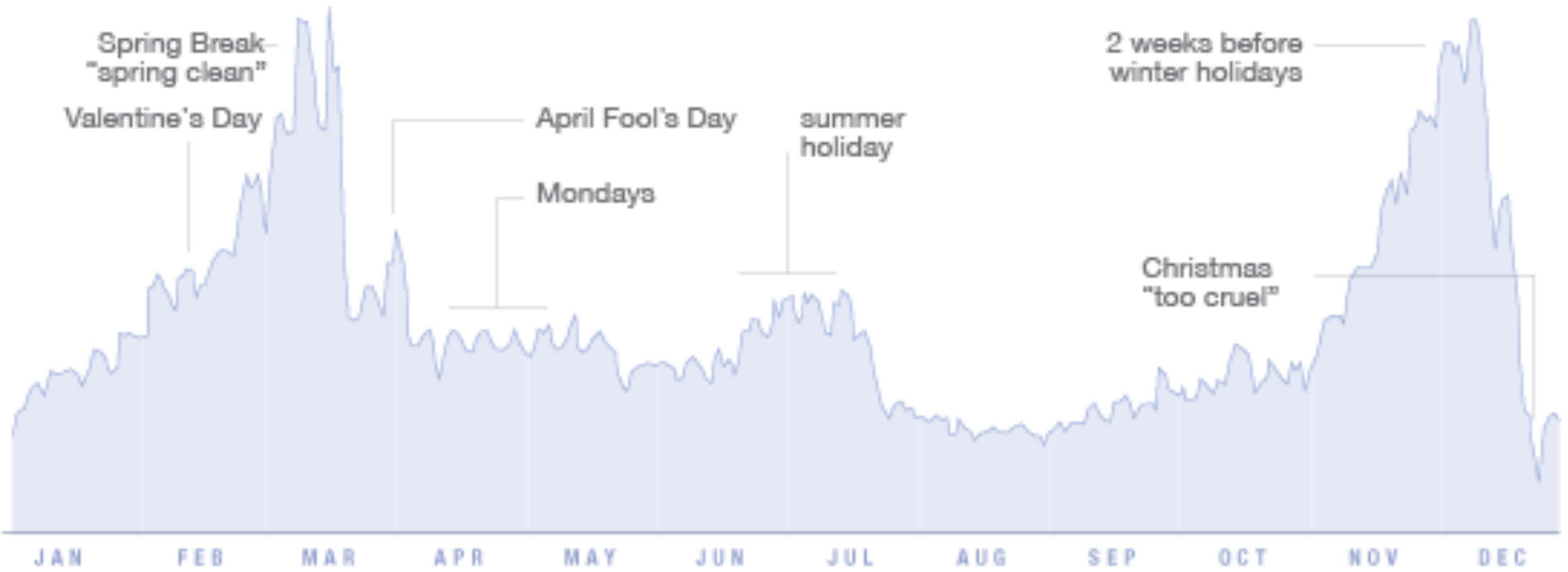
Peak Break-Up Times

According to Facebook status updates



David McCandless & Lee Byron
InformationIsBeautiful.net / LeeBryon.com

source: searches for "we broke up because"
taken from the infographic ultrabook
The Visual Miscellaneum

TED Talk: "The beauty of data visualization," David McCandless

Assessing Quantitative Skills

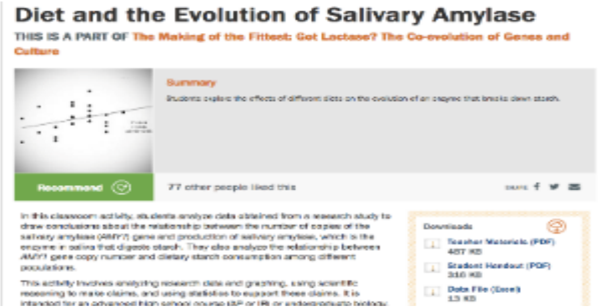
- Modeling assessment using Immediate Feedback Assessment Technique, (“IF-AT”) cards
  - http://www.epsteineducation.com/home/

Spreadsheet Tutorials to Analyze Amylase Copy Number and Diet

Rebecca Orr, Collin College, Ruth Buskirk and Kristin Harvey, U.T. Austin

Spreadsheet Data Analysis Tutorials

This series of self-paced tutorials show how to analyze data using a spreadsheet program.



Diet and the Evolution of Salivary Amylase

THIS IS A PART OF The Making of the Fittest: Got Lactase? The Co-evolution of Genes and Culture

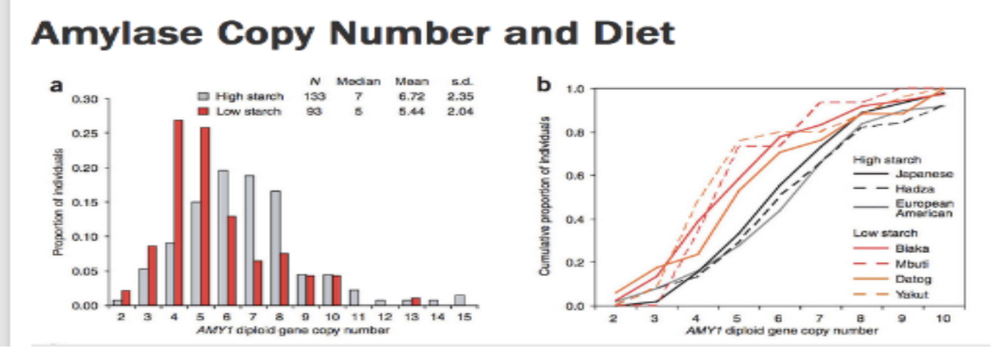
Students explore the effects of different diets on the evolution of an enzyme that breaks down starch.

77 other people liked this

In this classroom activity, students analyze data obtained from a research study to draw conclusions about the relationship between the number of copies of the salivary amylase (AMY1) gene and production of salivary amylase, which is the enzyme in saliva that digests starch. They also analyze the relationship between AMY1 gene copy number and dietary starch consumption among different populations.

This activity involves analyzing research data and graphing, using scientific reasoning to make claims, and using statistics to support these claims. It is intended for an advanced high school course (AP or IB) or undergraduate biology

Downloads
- Teacher Materials (PDF) 487 KB
- Student Handout (PDF) 316 KB
- Data File (Excel) 13 KB



https://qubeshub.org/qubesresources/publications/308/1

Exploring Descriptive Statistics

- Compare the mean and median for each population. Which value best describes the center of the data distribution (the central tendency) for each population?
- The standard deviation is the most widely used measure of variability. Which population has more variation around the mean?

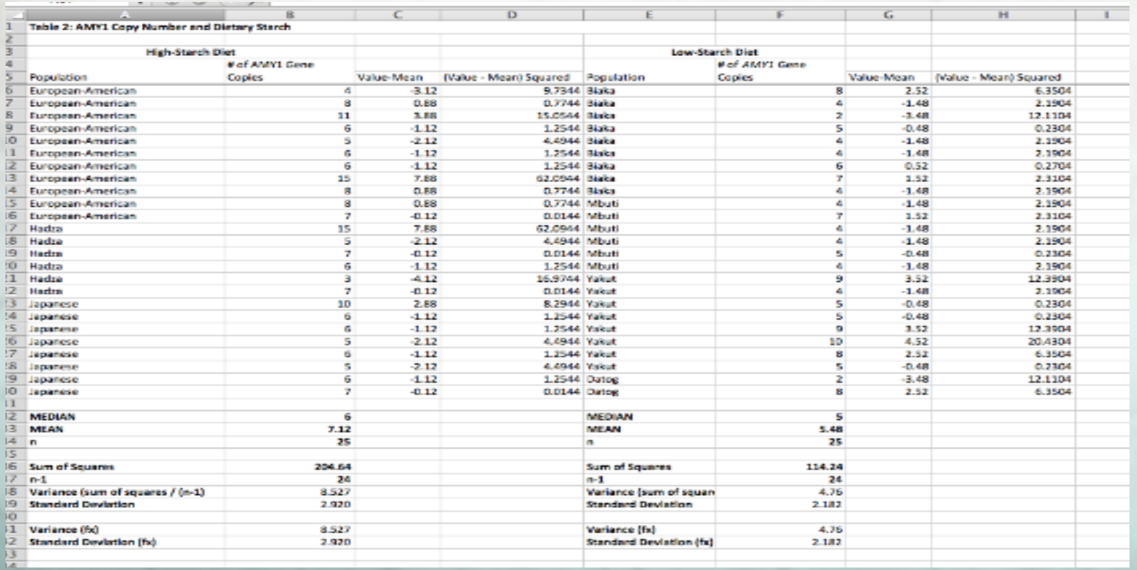


Table 2: AMY1 Copy Number and Dietary Starch

High-Starch Diet				Low-Starch Diet			
Population	# of AMY1 Gene Copies	Value-Mean	(Value - Mean) Squared	Population	# of AMY1 Gene Copies	Value-Mean	(Value - Mean) Squared
European-American	4	-3.12	9.7344	Biaka	8	2.52	6.3504
European-American	8	0.88	0.7744	Biaka	4	-1.48	2.1904
European-American	11	3.88	15.0544	Biaka	2	-3.48	12.1104
European-American	6	-1.12	1.2544	Biaka	5	-0.48	0.2304
European-American	5	-2.12	4.4944	Biaka	4	-1.48	2.1904
European-American	6	-1.12	1.2544	Biaka	4	-1.48	2.1904
European-American	6	-1.12	1.2544	Biaka	6	0.52	0.2704
European-American	15	7.88	62.0944	Biaka	7	1.52	2.3104
European-American	8	0.88	0.7744	Biaka	4	-1.48	2.1904
European-American	8	0.88	0.7744	Mbuti	4	-1.48	2.1904
European-American	7	-0.12	0.0144	Mbuti	7	1.52	2.3104
Hadza	15	7.88	62.0944	Mbuti	4	-1.48	2.1904
Hadza	5	-2.12	4.4944	Mbuti	4	-1.48	2.1904
Hadza	7	-0.12	0.0144	Mbuti	5	-0.48	0.2304
Hadza	6	-1.12	1.2544	Mbuti	4	-1.48	2.1904
Hadza	3	-4.12	16.9744	Yakut	9	3.52	12.3904
Hadza	7	-0.12	0.0144	Yakut	4	-1.48	2.1904
Japanese	10	2.88	8.2944	Yakut	5	-0.48	0.2304
Japanese	6	-1.12	1.2544	Yakut	5	-0.48	0.2304
Japanese	6	-1.12	1.2544	Yakut	9	3.52	12.3904
Japanese	5	-2.12	4.4944	Yakut	10	4.52	20.4304
Japanese	6	-1.12	1.2544	Yakut	8	2.52	6.3504
Japanese	5	-2.12	4.4944	Yakut	5	-0.48	0.2304
Japanese	6	-1.12	1.2544	Datog	2	-3.48	12.1104
Japanese	7	-0.12	0.0144	Datog	8	2.52	6.3504
MEDIAN	6			**MEDIAN**	5		
MEAN	7.12			**MEAN**	5.48		
n	25			**n**	25		
Sum of Squares	204.64			**Sum of Squares**	114.24		
n-1	24			**n-1**	24		
Variance (sum of squares / (n-1)	8.527			**Variance (sum of squar**	4.76		
Standard Deviation	2.920			**Standard Deviation**	2.182		
Variance (fx)	8.527			**Variance (fx)**	4.76		
Standard Deviation (fx)	2.920			**Standard Deviation (fx)**	2.182		

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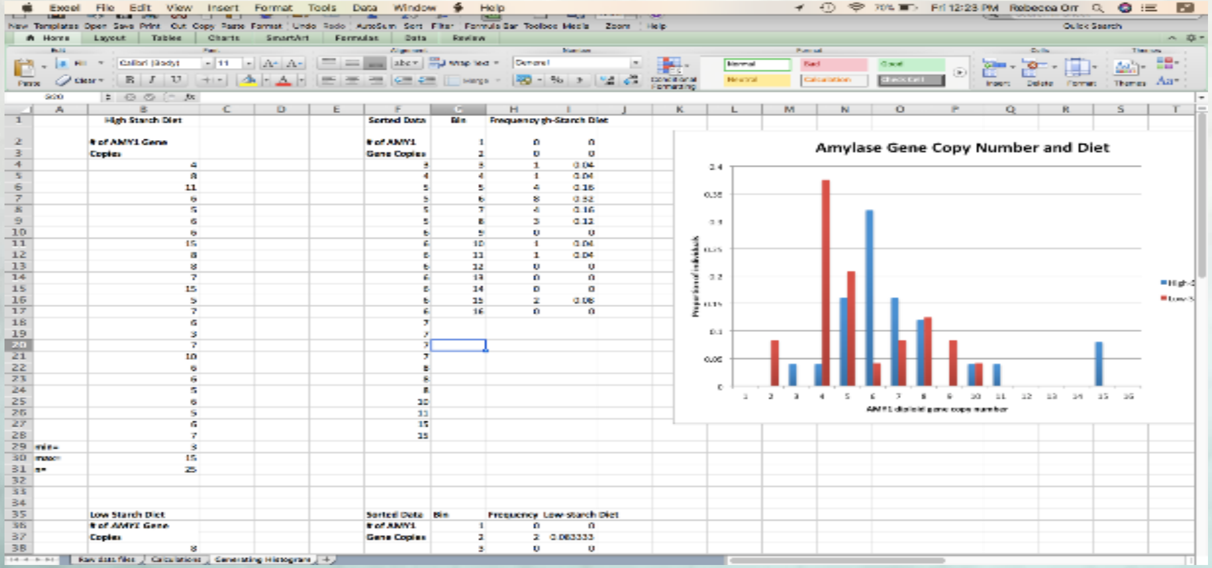
Using a Histogram to Evaluate Data Distribution

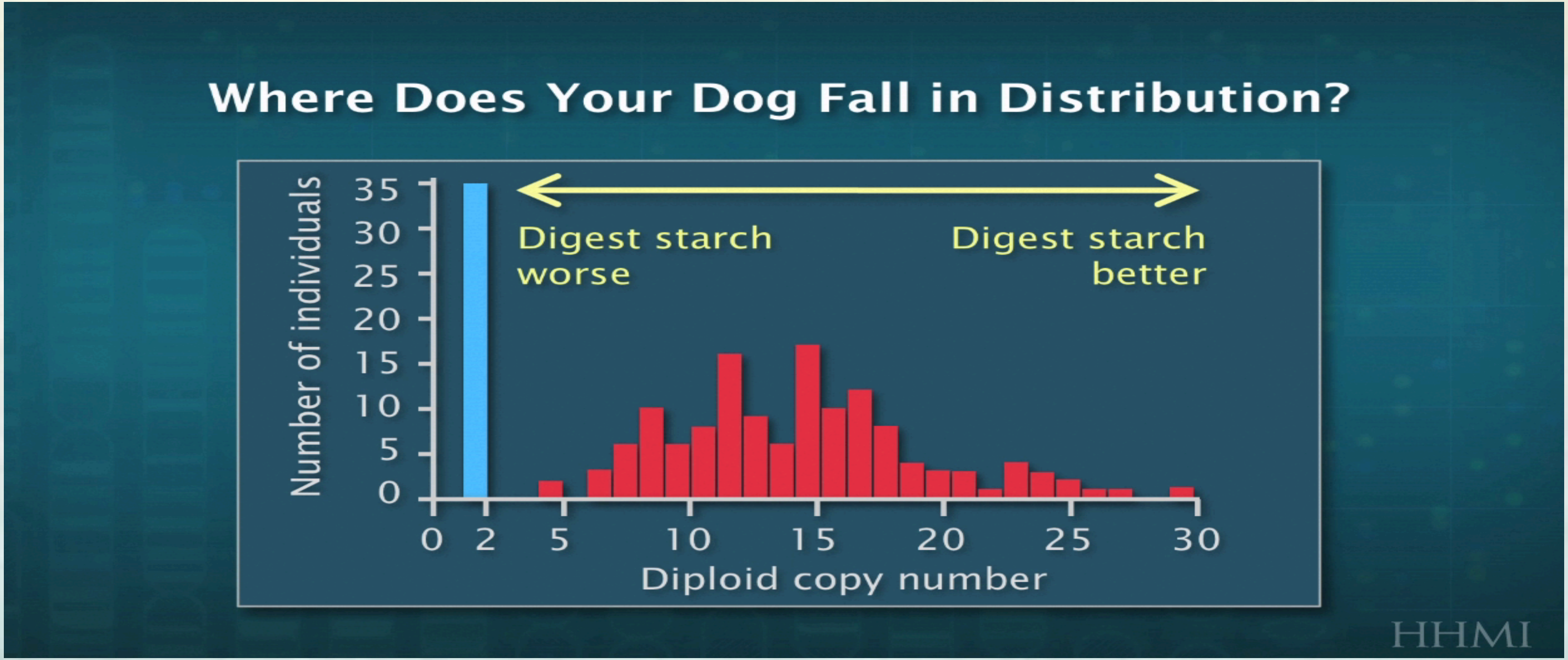
- A histogram is a graph of frequency distribution. It graphs how many data points fall between a range of values, and is a very useful graph for illustrating data distribution.

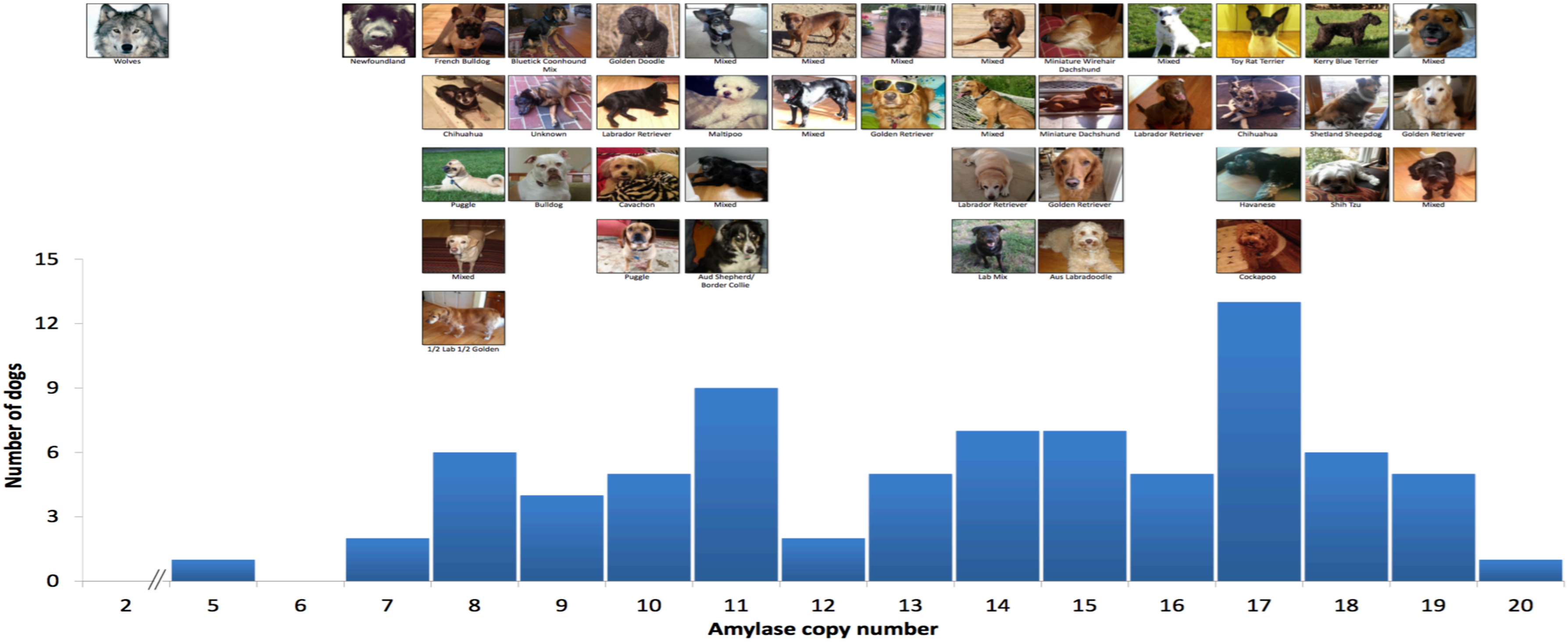

Excel File Edit View Insert Format Tools Data Window Help
Home Layout Tables Charts SmartArt Formulas Data Review
Calibri (Body) 11
General
Normal Bad Good Neutral Calculation Check Cell
Raw data files Calculations Generating Histogram
Amylase Gene Copy Number and Diet
Proportion of individuals
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
AMY1 diploid gene copy number
High-S
Low-S

	A	B	F	G	H	I
1		High Starch Diet	Sorted Data	Bin	Frequency gh-Starch Diet	
2		# of AMY1 Gene	# of AMY1	1	0	0
3		Copies	Gene Copies	2	0	0
4		4	3	3	1	0.04
5		8	4	4	1	0.04
6		11	5	5	4	0.16
7		6	5	6	8	0.32
8		5	5	7	4	0.16
9		6	5	8	3	0.12
10		6	6	9	0	0
11		15	6	10	1	0.04
12		8	6	11	1	0.04
13		8	6	12	0	0
14		7	6	13	0	0
15		15	6	14	0	0
16		5	6	15	2	0.08
17		7	6	16	0	0
18		6	7			
19		3	7			
20		7	7			
21		10	7			
22		6	8			
23		6	8			
24		5	8			
25		6	10			
26		5	11			
27		6	15			
28		7	15			
29	min=	3				
30	max=	15				
31	n=	25				
32						
33						
34						
35		Low Starch Diet	Sorted Data	Bin	Frequency	Low-starch Diet
36		# of AMY1 Gene	# of AMY1	1	0	0
37		Copies	Gene Copies	2	2	0.083333
38		8		3	0	0

- How do the centers of each population compare with each other?
- How does the distribution of gene frequencies compare in each population?

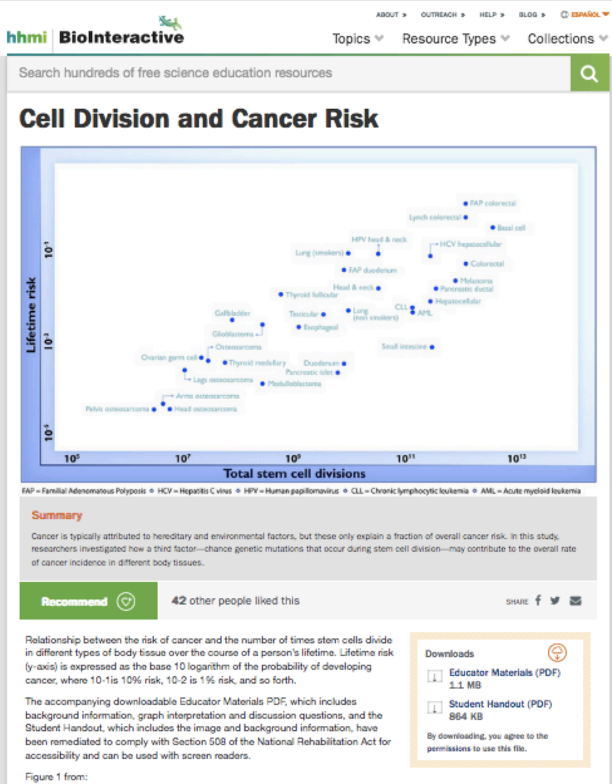
http://media.hhmi.org/hl/13Discussion1.html




Wolves
Newfoundland
French Bulldog
Bluetick Coonhound Mix
Golden Doodle
Mixed
Mixed
Mixed
Mixed
Miniature Wirehair Dachshund
Mixed
Toy Rat Terrier
Kerry Blue Terrier
Mixed
Chihuahua
Unknown
Labrador Retriever
Maltipoo
Mixed
Golden Retriever
Mixed
Miniature Dachshund
Labrador Retriever
Chihuahua
Shetland Sheepdog
Golden Retriever
Puggle
Bulldog
Cavachon
Mixed
Labrador Retriever
Golden Retriever
Havanese
Shih Tzu
Mixed
Mixed
Puggle
Aud Shepherd/ Border Collie
Lab Mix
Aus Labradoodle
Cockapoo
1/2 Lab 1/2 Golden
Number of dogs
15
12
9
6
3
0
2
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Amylase copy number

Calculating Lifetime Cancer Risk Resulting from DNA Replication

- Rebecca Orr, Collin College, Ruth Buskirk and Kristin Harvey, U.T. Austin



Cell Division and Cancer Risk

FAP = Familial Adenomatous Polyposis • HCV = Hepatitis C virus • HPV = Human papillomavirus • CLL = Chronic lymphocytic leukemia • AML = Acute myeloid leukemia

Summary

Cancer is typically attributed to hereditary and environmental factors, but these only explain a fraction of overall cancer risk. In this study, researchers investigated how a third factor—chance genetic mutations that occur during stem cell division—may contribute to the overall rate of cancer incidence in different body tissues.

42 other people liked this

Relationship between the risk of cancer and the number of times stem cells divide in different types of body tissue over the course of a person's lifetime. Lifetime risk (y-axis) is expressed as the base 10 logarithm of the probability of developing cancer, where 10-1is 10% risk, 10-2 is 1% risk, and so forth.

The accompanying downloadable Educator Materials PDF, which includes background information, graph interpretation and discussion questions, and the Student Handout, which includes the image and background information, have been remediated to comply with Section 508 of the National Rehabilitation Act for accessibility and can be used with screen readers.

Figure 1 from:

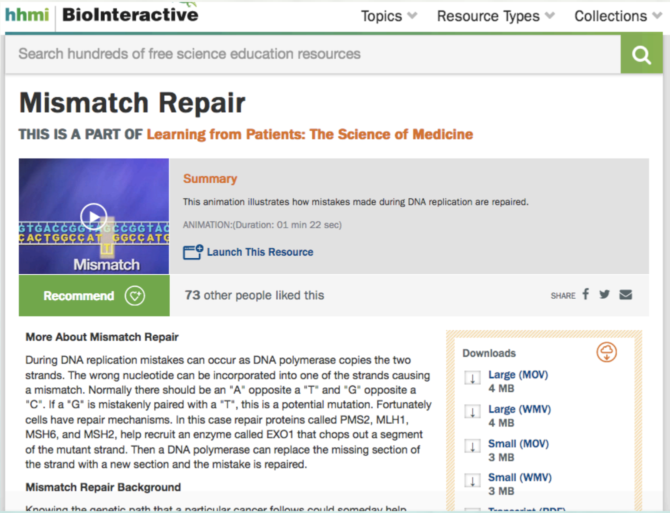
Downloads

Educator Materials (PDF)
1.1 MB

Student Handout (PDF)
864 KB

By downloading, you agree to the permissions to use this file.

- Took existing Data Point resource, Mismatch Repair Animation, and Science in the Classroom, created a story to add relevance



Mismatch Repair

THIS IS A PART OF **Learning from Patients: The Science of Medicine**

Summary

This animation illustrates how mistakes made during DNA replication are repaired.

ANIMATION:(Duration: 01 min 22 sec)

Launch This Resource

73 other people liked this

More About Mismatch Repair

During DNA replication mistakes can occur as DNA polymerase copies the two strands. The wrong nucleotide can be incorporated into one of the strands causing a mismatch. Normally there should be an "A" opposite a "T" and "G" opposite a "C". If a "G" is mistakenly paired with a "T", this is a potential mutation. Fortunately cells have repair mechanisms. In this case repair proteins called PMS2, MLH1, MSH6, and MSH2, help recruit an enzyme called EXO1 that chops out a segment of the mutant strand. Then a DNA polymerase can replace the missing section of the strand with a new section and the mistake is repaired.

Mismatch Repair Background

Knowing the genetic path that a particular cancer follows could someday help

Downloads

Large (MOV)
4 MB

Large (WMV)
4 MB

Small (MOV)
3 MB

Small (WMV)
3 MB

Transcript (PDF)

- Added specific content instruction on stem cells, DNA replication, & proof reading/ mismatch repair.

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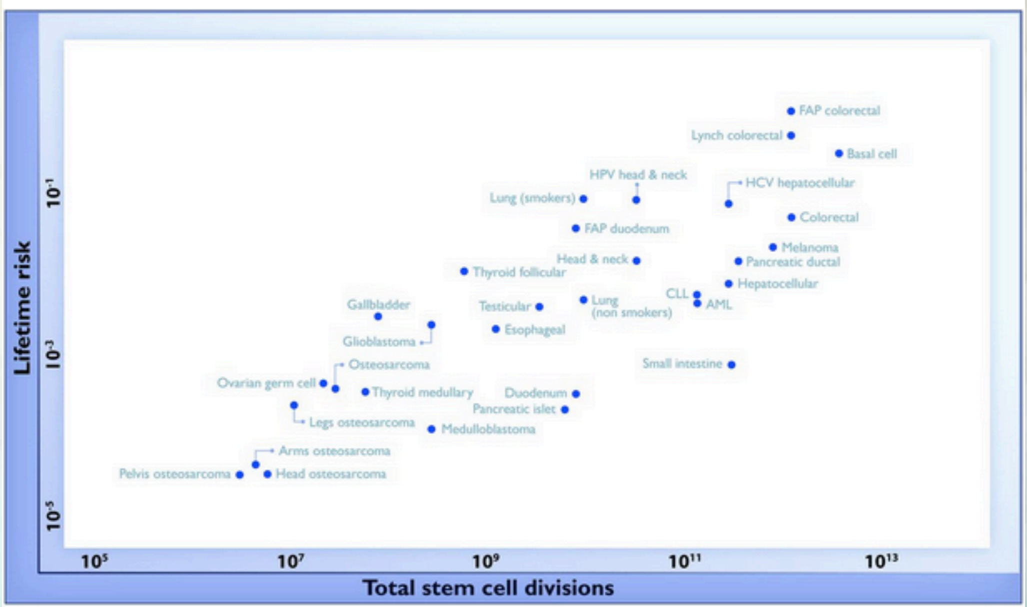
Evaluating Scatterplots

- Created questions to build skills in
  - Process of science
  - Evaluating Pearson correlation coefficient (r) to identify relationships between variables

- Activity was designed to fit into a team-based learning environment.



Explore implementing these resources…

- With the collaborators you identified at lunch, in groups of 2-3, plan how you might implement one or more of these resources in your classroom (45 min)
- Report out within your table

Additional Resources

NSF NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

DATA Nuggets

QUBES

The Power of Biology × Math × Community

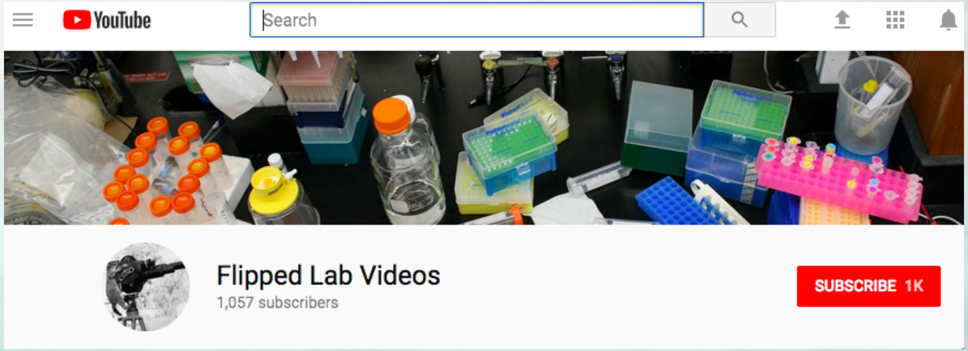
DRYAD LAB

Science in the Classroom AAAS

Annotated research papers and accompanying teaching materials

Case It!

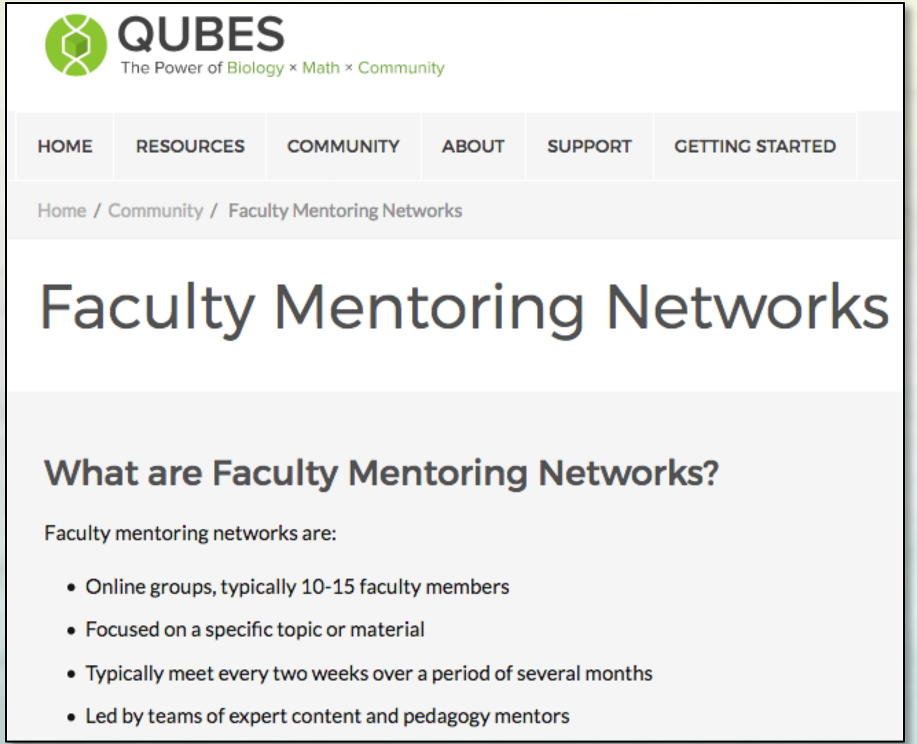
Molecular Biology Simulations for Case-Based Learning in Biology



Flipped Lab Videos

1,057 subscribers

You don't have to do it alone!


QUBES
The Power of Biology × Math × Community
HOME
RESOURCES
COMMUNITY
ABOUT
SUPPORT
GETTING STARTED
Home / Community / Faculty Mentoring Networks

Faculty Mentoring Networks

What are Faculty Mentoring Networks?

Faculty mentoring networks are:

- Online groups, typically 10-15 faculty members
- Focused on a specific topic or material
- Typically meet every two weeks over a period of several months
- Led by teams of expert content and pedagogy mentors

https://qubeshub.org/community/fmn

1. **Join an FMN**
2. **Modify existing materials**

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Don't forget to fill out your evaluations!