

Online Learning Strategies for Enhancing Students' Understanding of Science & Health

Louisa A. Stark, Ph.D.
Director



Genetic Science

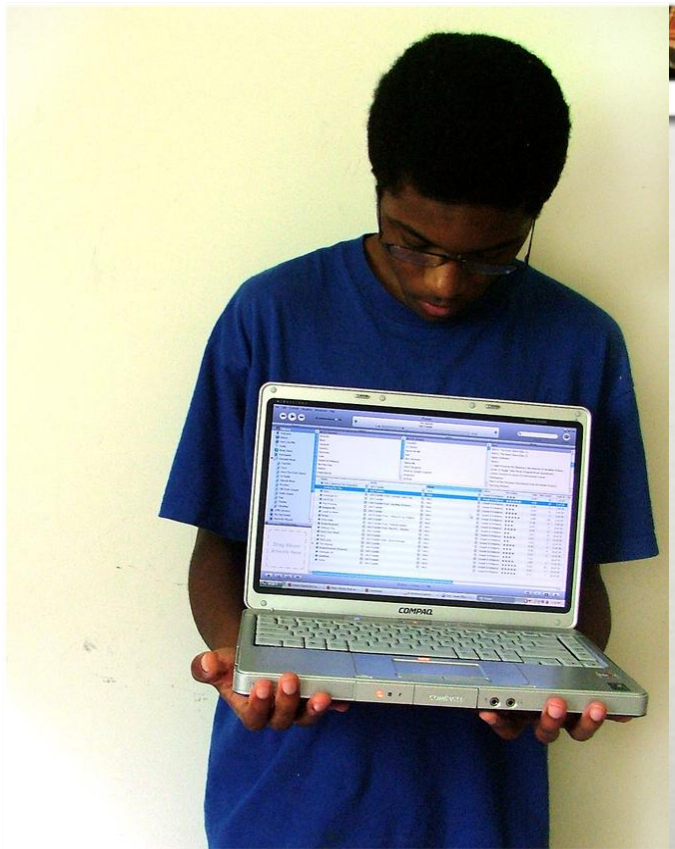
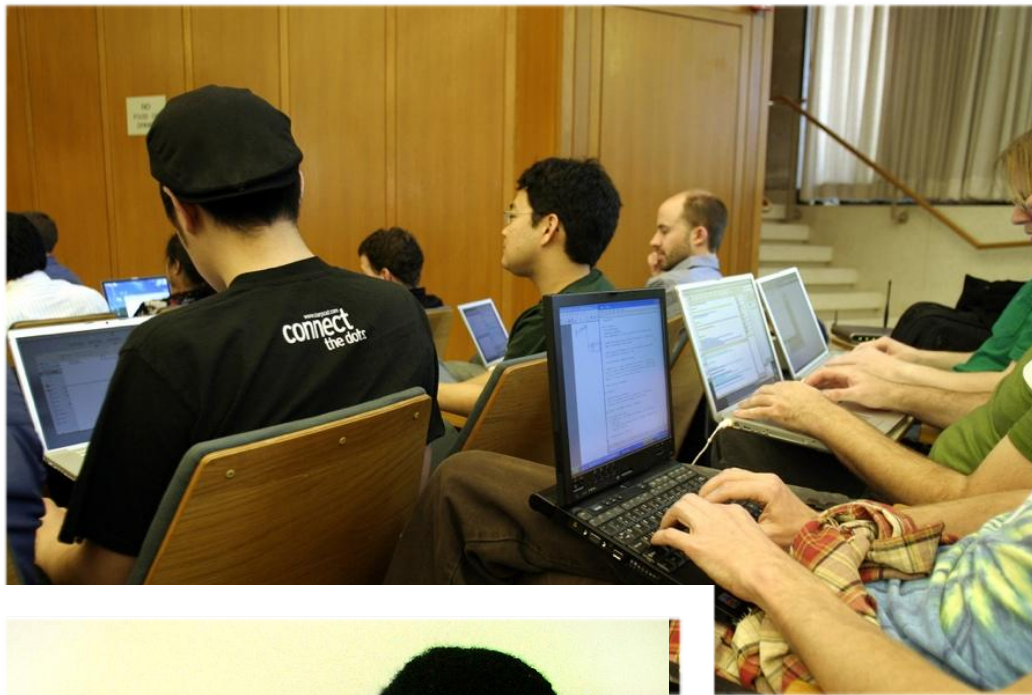


Learning Center

University of Utah
Department of Human Genetics

Talk Outline

- Today's students & technology
- Examples of online learning experiences
- GSLC research studies





Louisa Stark

Friends

Message

Give Gift

More

Timeline

About

Photos 3

Friends 3 Mutual

More

About

Worked at The University of Utah

Studied at University of Colorado Boulder
Past: Wilmington College and Grand Valley State University

Lives in Salt Lake City, Utah

Photos - 3



Friends - 31 (3 Mutual)



Places



Likes - 4



Post Photo

Write something...



Martha Stark » Louisa Stark

April 7

Happy Birthday! I tried to call, but got voicemail at both numbers I have for you. Hope you had a good weekend, and had time for something other than work.

Like · Comment



Chad Austin » Louisa Stark

April 5

Happy Birthday! 🎂

Like · Comment



Mario Godoy-Gonzalez » Louisa Stark

April 4 via mobile

Happy Birthday, Louisa!!! Have a wonderful day.

Like · Comment



6 friends posted on Louisa's timeline on her birthday
April 5, 2012



Chad Austin wrote on Louisa Stark's timeline.
April 5, 2012 at 9:13pm

Happy Birthday!!!! I hope you are having a fabulous time

Like · Comment



Dori Hess wrote on Louisa Stark's timeline.
April 5, 2012 at 9:06pm

Happy Birthday Louisa!

Like · Comment

Now
2010
Born

Sponsored

Evergreen MTB Festival



Issaquah, WA June 8th. Mountain bike demos, rides,

Home

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Discover

Me

Search

Louisa Stark

View my profile page

4 TWEETS

10 FOLLOWING

20 FOLLOWERS

Compose new Tweet...

Who to follow · Refresh · View all

Aereo

@AereoTV

Promoted · Follow

National Science Fdn

@NSF

Followed by Utah EPSCoR and ot...

Follow

Patrice Kurnath

@PKurnath

Follow

Browse categories · Find friends

Trends · Change

#BluePomSmoothie

Promoted

#LiteraryPaperOpenings

Paul George

#utpol

Kim Dotcom

#IDontLikeWhen

#tweetliketheoppositgender

#DareToBare

Paris Hilton

Drummer Lee Rigby

Tweets

POINT OF INQUIRY

Point of Inquiry @pointofinquiry

Our latest episode with the great Katha Pollitt, right off the presses from #WISCFI @KathaPollitt @chriscmooney pointofinquiry.org/katha_pollitt_...

Retweeted by Chris Mooney

Expand

Goldman Sachs

Goldman Sachs @GoldmanSachs

92 meetings & 42,000 hours of training in 20 offices to discuss the importance of personal accountability link.gs.com/Foqx

Promoted by Goldman Sachs

Expand

Center for Inquiry

Center for Inquiry @center4inquiry

Katha Pollitt - Is Religion Inherently Sexist? - The latest Point of Inquiry, with Chris Mooney pointofinquiry.org/katha_pollitt_...

Retweeted by Chris Mooney

Expand

Chris Mooney

Chris Mooney @chriscmooney

Economically, Could Obama Be America's Best President? - Forbes onforb.es/148DqGQ

View summary

Kate Sheppard

Kate Sheppard @kate_sheppard

I will be on MSNBC's @ThomasARoberts Show at 11:30 a.m. today. Tune in!

Retweeted by Chris Mooney

Expand

Chris Mooney

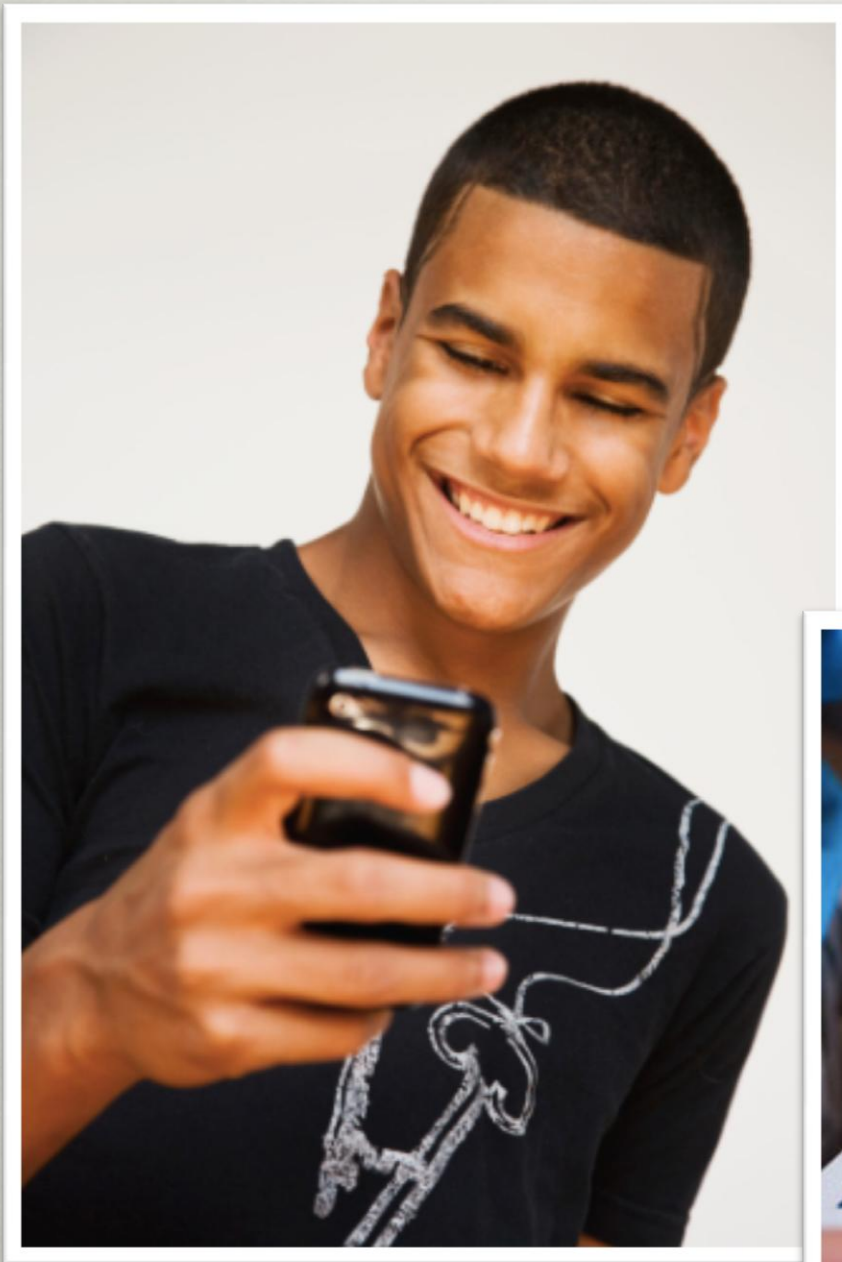
Chris Mooney @chriscmooney

New @pointofinquiry with @kathapollitt Is Religion Inherently Sexist? pointofinquiry.org/katha_pollitt_...

Expand

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Science
Learning
Center

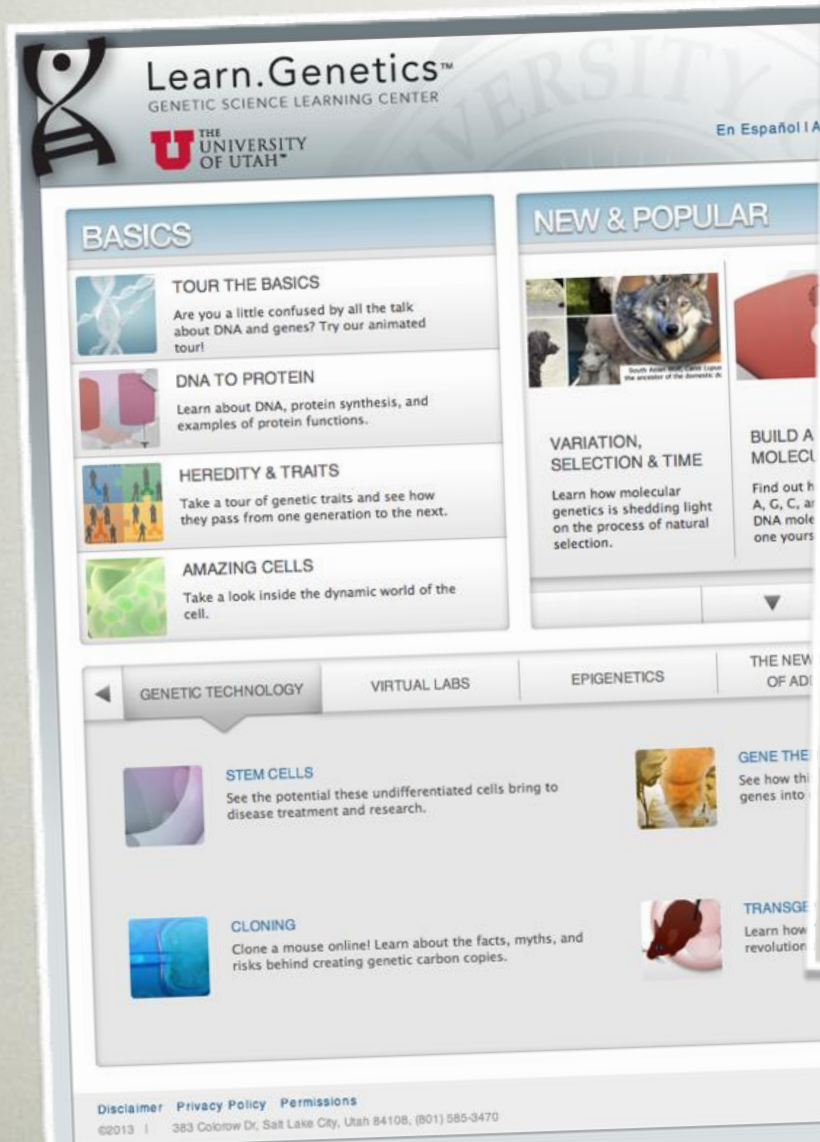








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BASICS

- TOUR THE BASICS**
Are you a little confused by all the talk about DNA and genes? Try our animated tour!
- DNA TO PROTEIN**
Learn about DNA, protein synthesis, and examples of protein functions.
- HEREDITY & TRAITS**
Take a tour of genetic traits and see how they pass from one generation to the next.
- AMAZING CELLS**
Take a look inside the dynamic world of the cell.

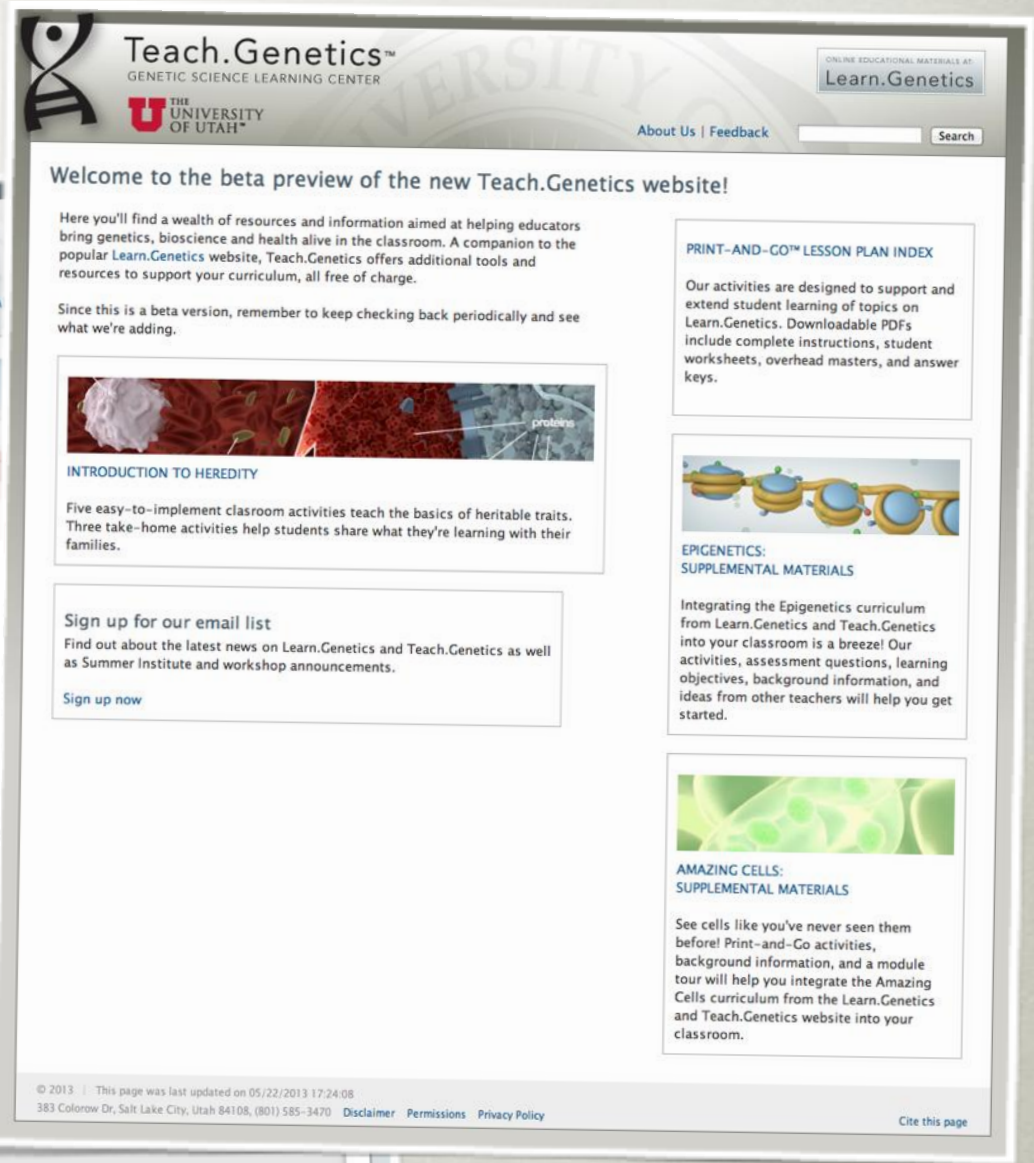
NEW & POPULAR

- VARIATION, SELECTION & TIME**
Learn how molecular genetics is shedding light on the process of natural selection.
- BUILD A MOLECULE**
Find out how A, G, C, and T DNA molecules are built.

GENETIC TECHNOLOGY | **VIRTUAL LABS** | **EPIGENETICS** | **THE NEW OF ADI**

- STEM CELLS**
See the potential these undifferentiated cells bring to disease treatment and research.
- CLONING**
Clone a mouse online! Learn about the facts, myths, and risks behind creating genetic carbon copies.
- GENE THERAPY**
See how this new technology is changing lives.
- TRANSGENIC**
Learn how genetic engineering is revolutionizing science.

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Welcome to the beta preview of the new Teach.Genetics website!

Here you'll find a wealth of resources and information aimed at helping educators bring genetics, bioscience and health alive in the classroom. A companion to the popular Learn.Genetics website, Teach.Genetics offers additional tools and resources to support your curriculum, all free of charge.

Since this is a beta version, remember to keep checking back periodically and see what we're adding.

PRINT-AND-GO™ LESSON PLAN INDEX

Our activities are designed to support and extend student learning of topics on Learn.Genetics. Downloadable PDFs include complete instructions, student worksheets, overhead masters, and answer keys.

INTRODUCTION TO HEREDITY

Five easy-to-implement classroom activities teach the basics of heritable traits. Three take-home activities help students share what they're learning with their families.

EPIGENETICS: SUPPLEMENTAL MATERIALS

Integrating the Epigenetics curriculum from Learn.Genetics and Teach.Genetics into your classroom is a breeze! Our activities, assessment questions, learning objectives, background information, and ideas from other teachers will help you get started.

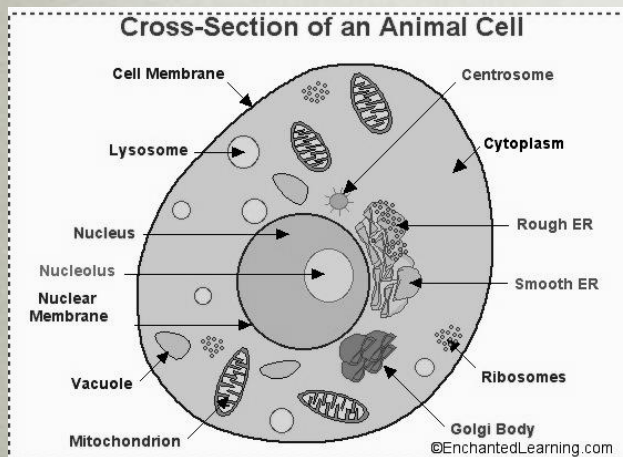
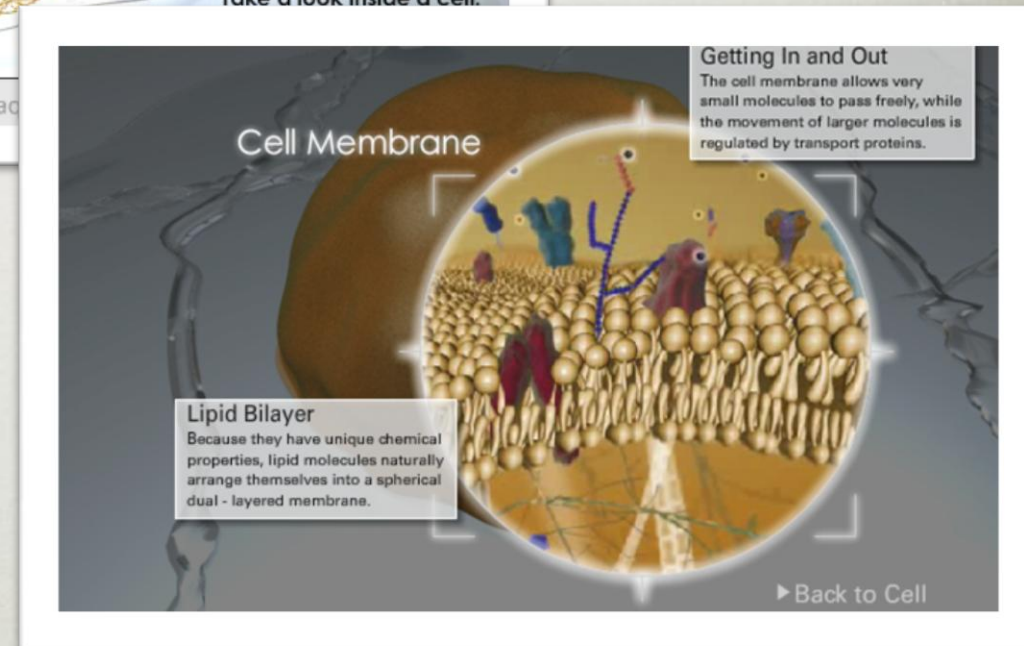
AMAZING CELLS: SUPPLEMENTAL MATERIALS

See cells like you've never seen them before! Print-and-Go activities, background information, and a module tour will help you integrate the Amazing Cells curriculum from the Learn.Genetics and Teach.Genetics website into your classroom.

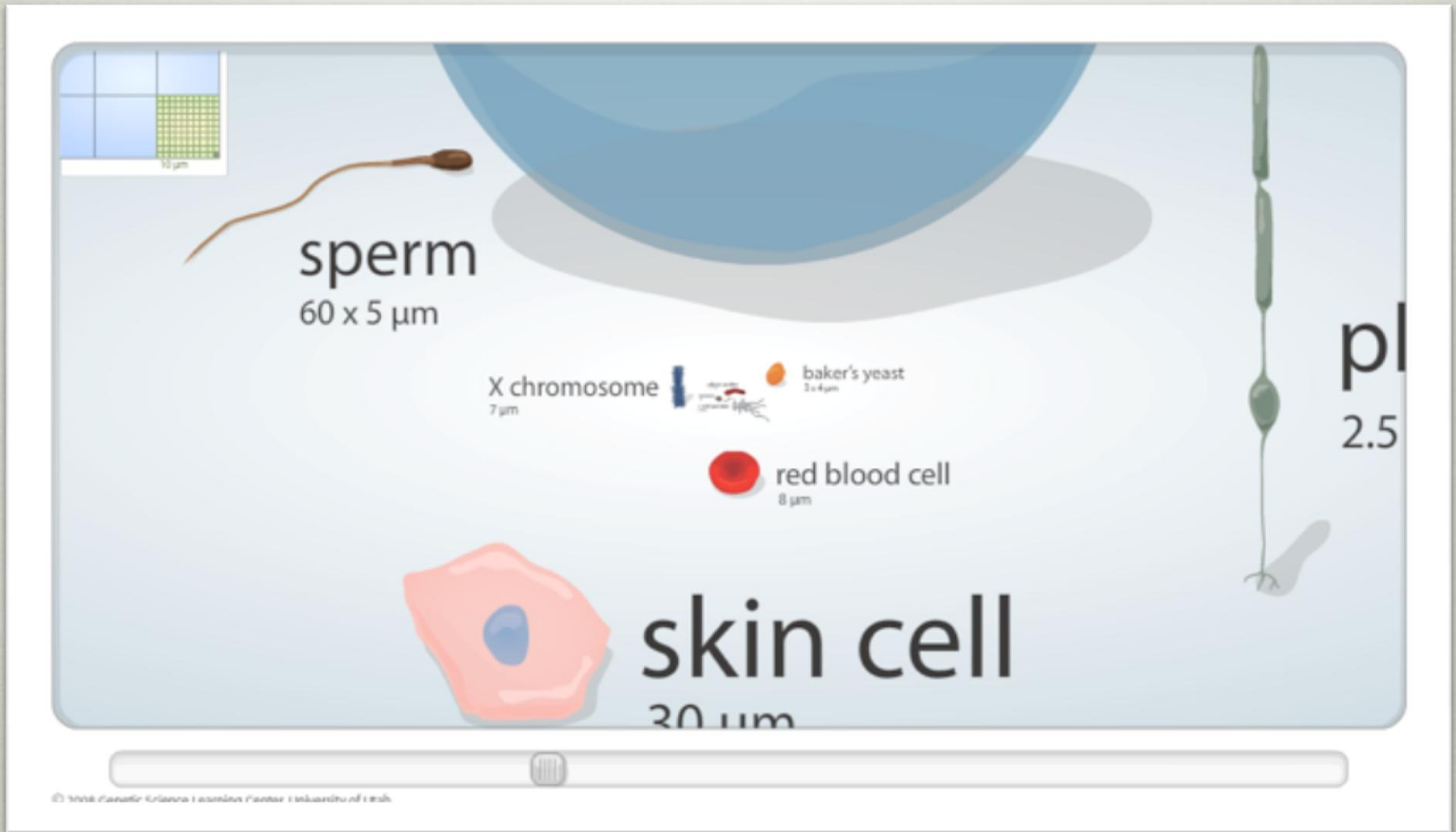
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Find out about the latest news on Learn.Genetics and Teach.Genetics as well as Summer Institute and workshop announcements.
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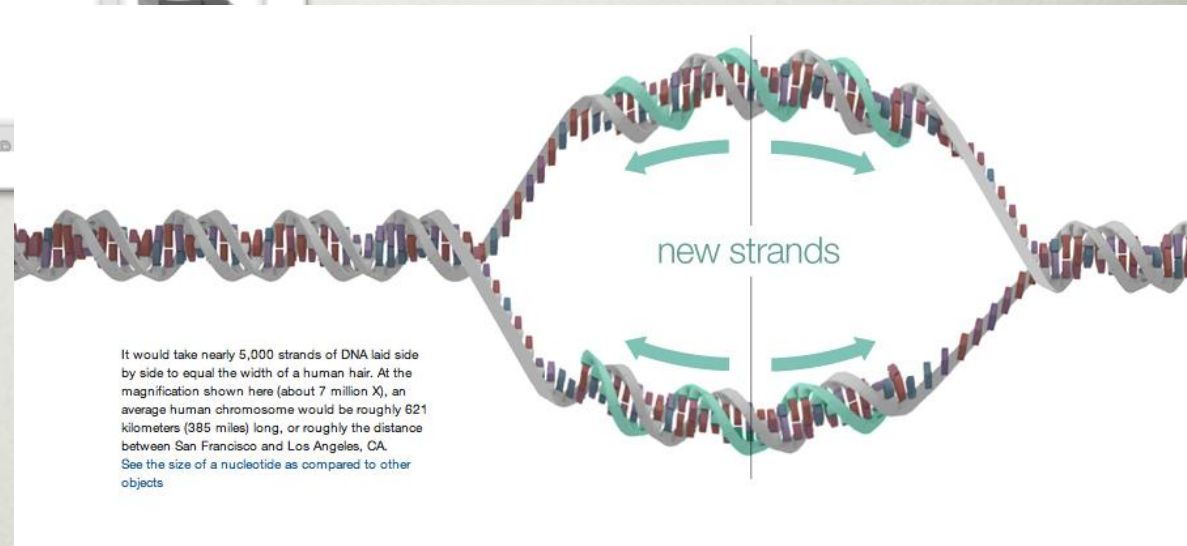
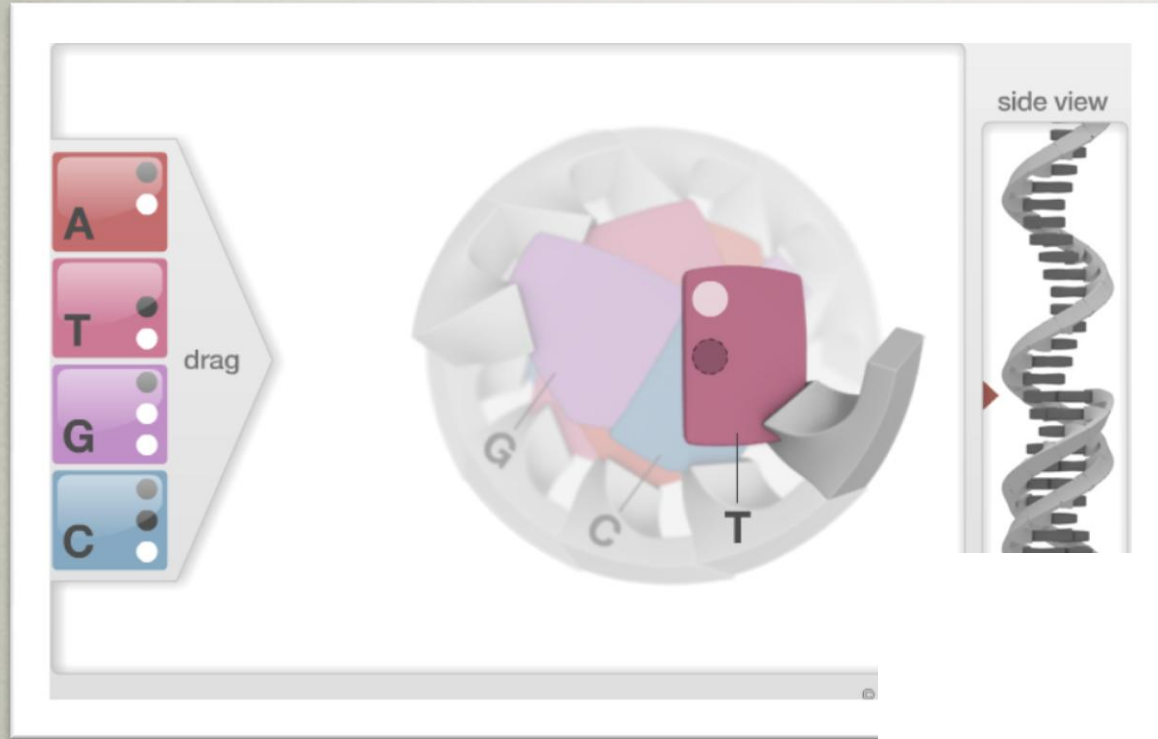
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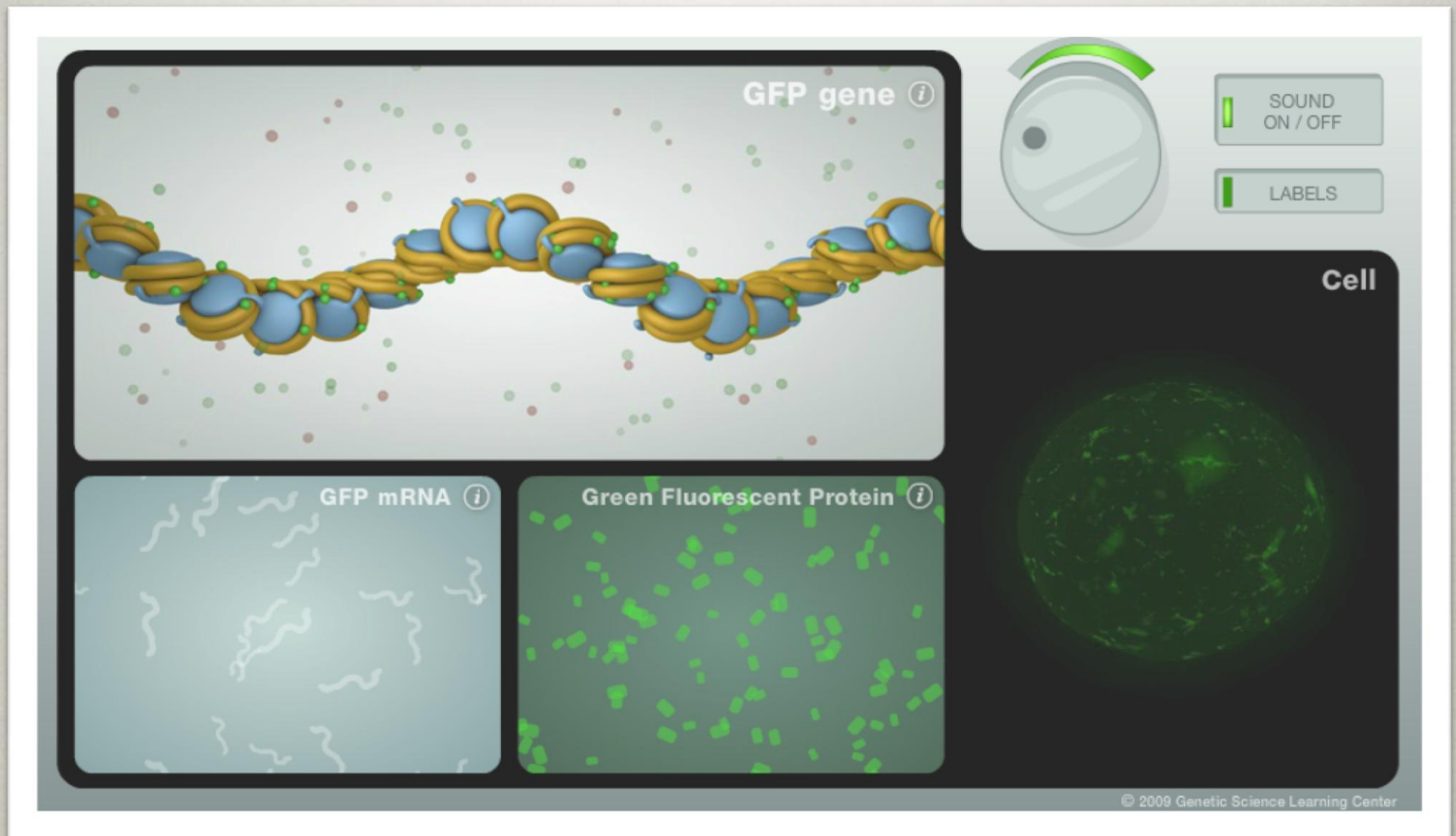
Inside a Cell



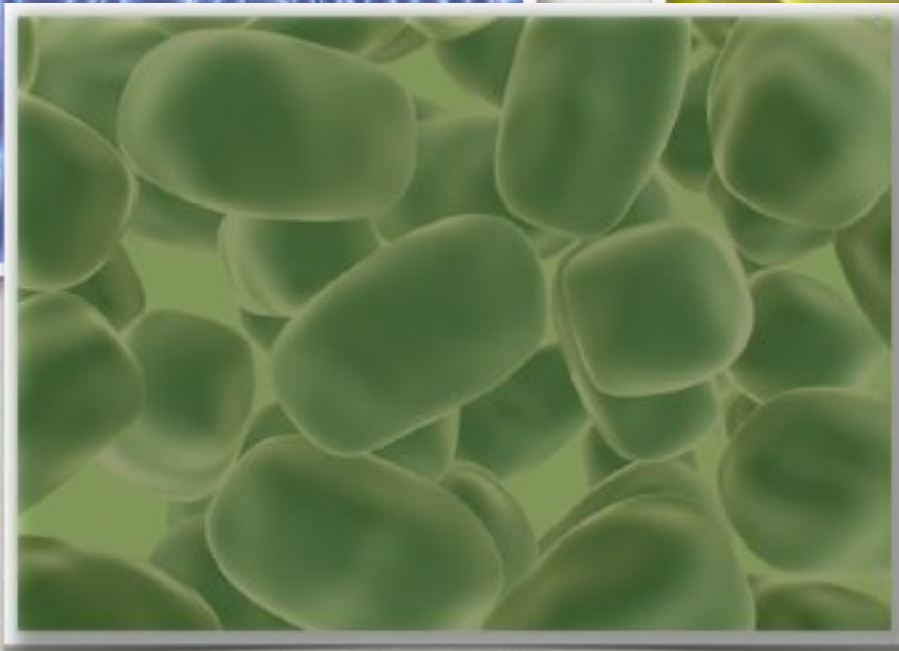
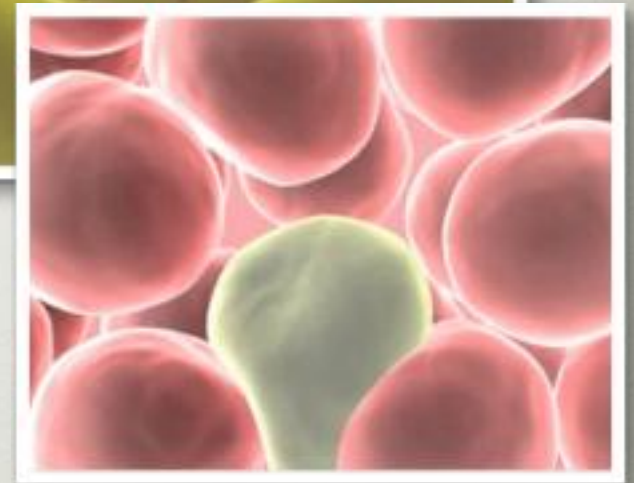
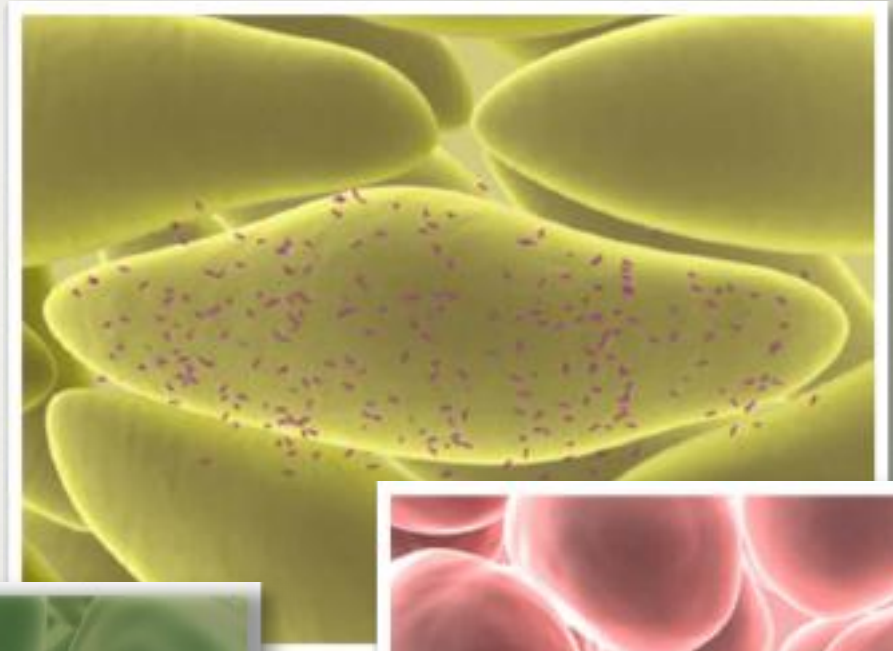
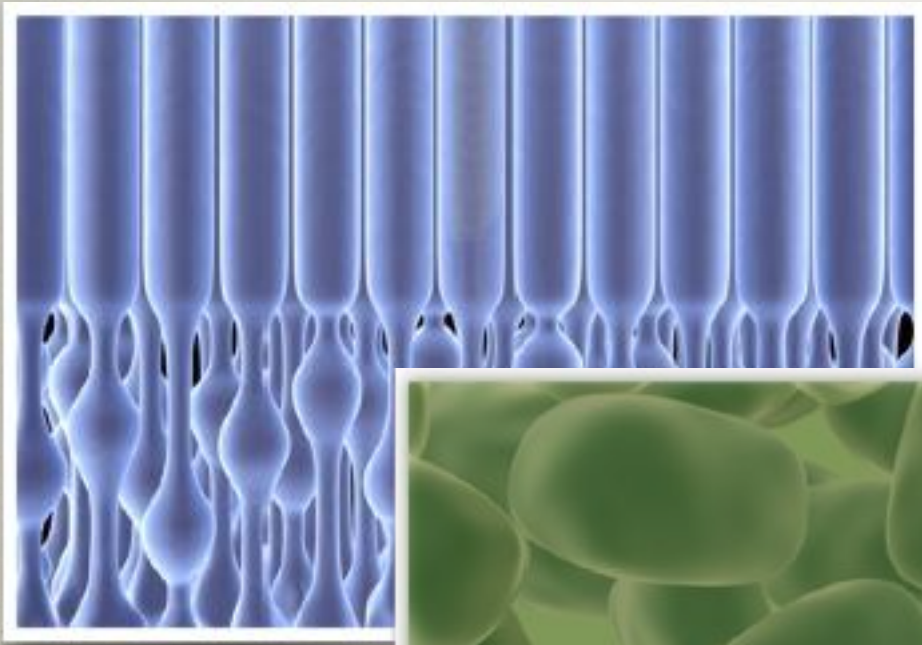
Cell Size and Scale



Build a DNA Molecule

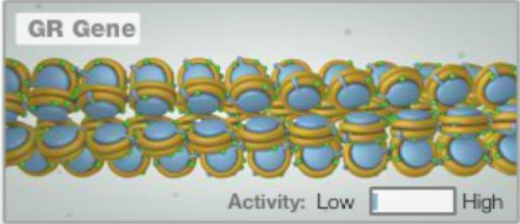


Gene Control



Dropping Signals

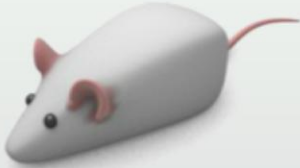
GR Gene



Activity: Low High

Timeline

birth 1 2 3 4 5 6 7 days




START

You get to be the rat mom!


AUDIO

Deep in the brain of a newborn rat pup, methyl molecules (green) silence the GR gene. When it's active, the GR gene produces a protein that helps the body relax after a stressful event. The type of care a pup receives from its mother during the first week of life can change the expression of this gene.

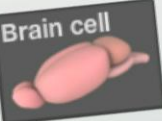
Mom




GR gene



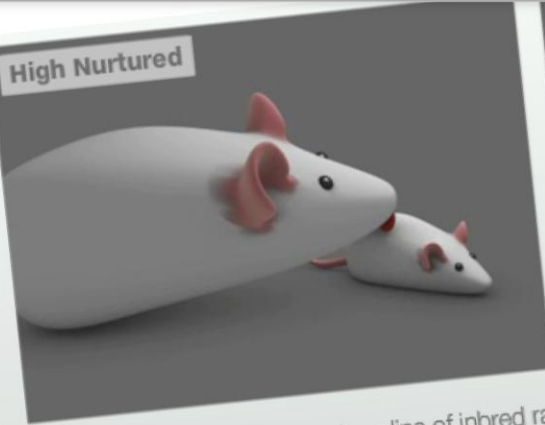
Brain cell



Adult pup

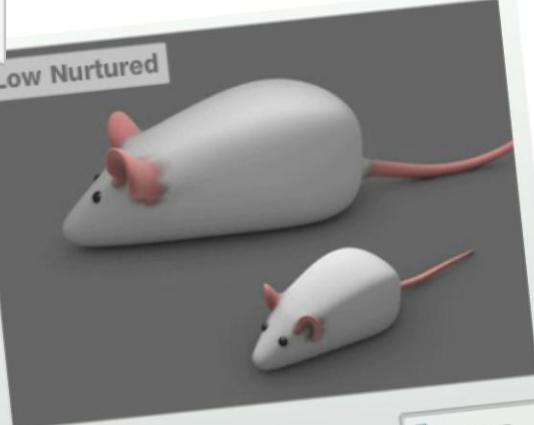


High Nurtured



These mothers come from a long line of inbred rats, so their genomes are highly similar. But they care for their pups very differently.

Low Nurtured

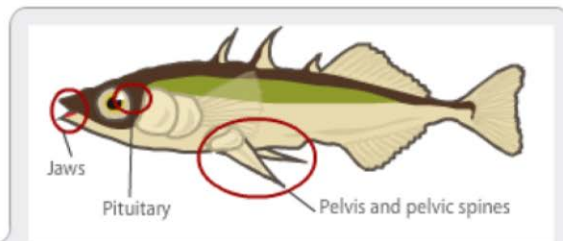
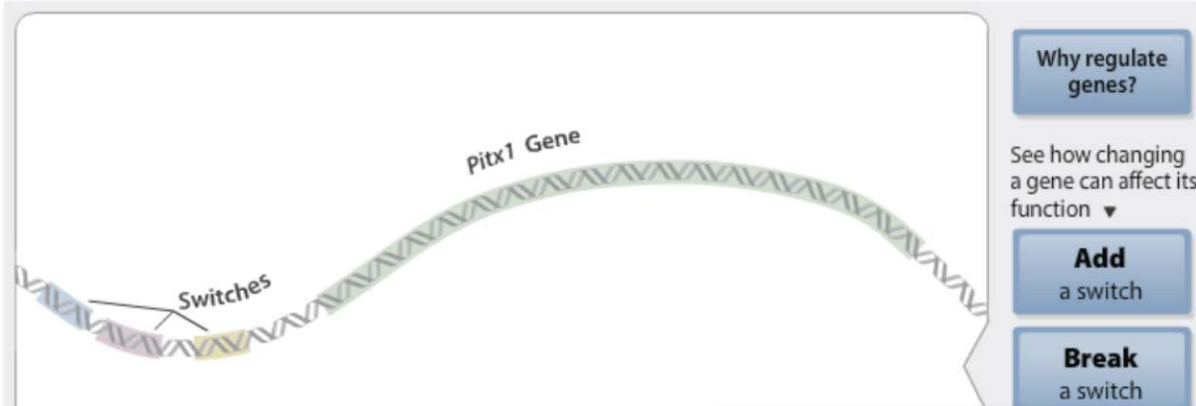


AUDIO

Lick a rat pup:

GO!

Lick Your Rats



This is an interactive simulation interface. At the top, it features the same **Pitx1 Gene** diagram with **Switches** and a **Gene product (Protein)** shown as an orange blob. Below the gene diagram are two embryo images: **Normal Pitx1** (left) and **Modified coding region** (right). The right embryo shows a red circle around its pelvic region. On the right side of the interface is a control panel with buttons: **Why regulate genes?**, **Add a switch**, **Break a switch**, **Modify a switch**, and **Modify the Gene**. At the bottom right are navigation controls: a left arrow, a **Done** button, and icons for **CC**, a speaker, and a signal strength indicator. Below these icons is the text "References & Credits".

Old Genes, New Tricks



Mouse Party

Utah Üniversitesi Genetic Science Learning Center , tarafından hazırlanan uyğurturucu maddelerin beyin ve insan sağlığı üzerindeki yıkıcı etkilerini anlatan etkili bir animasyon hazırlamış. Sadece fareleri tutup koltuğa oturmanız yeterli.
<http://learn.genetics.utah.edu/units/addiction/drugs/mouse.cfm>



Mou

CONTENTS

<https://addic.drugs/mouse.cfm>

POSTED BY PRASANT SIVADASAN AT 5:50 AM

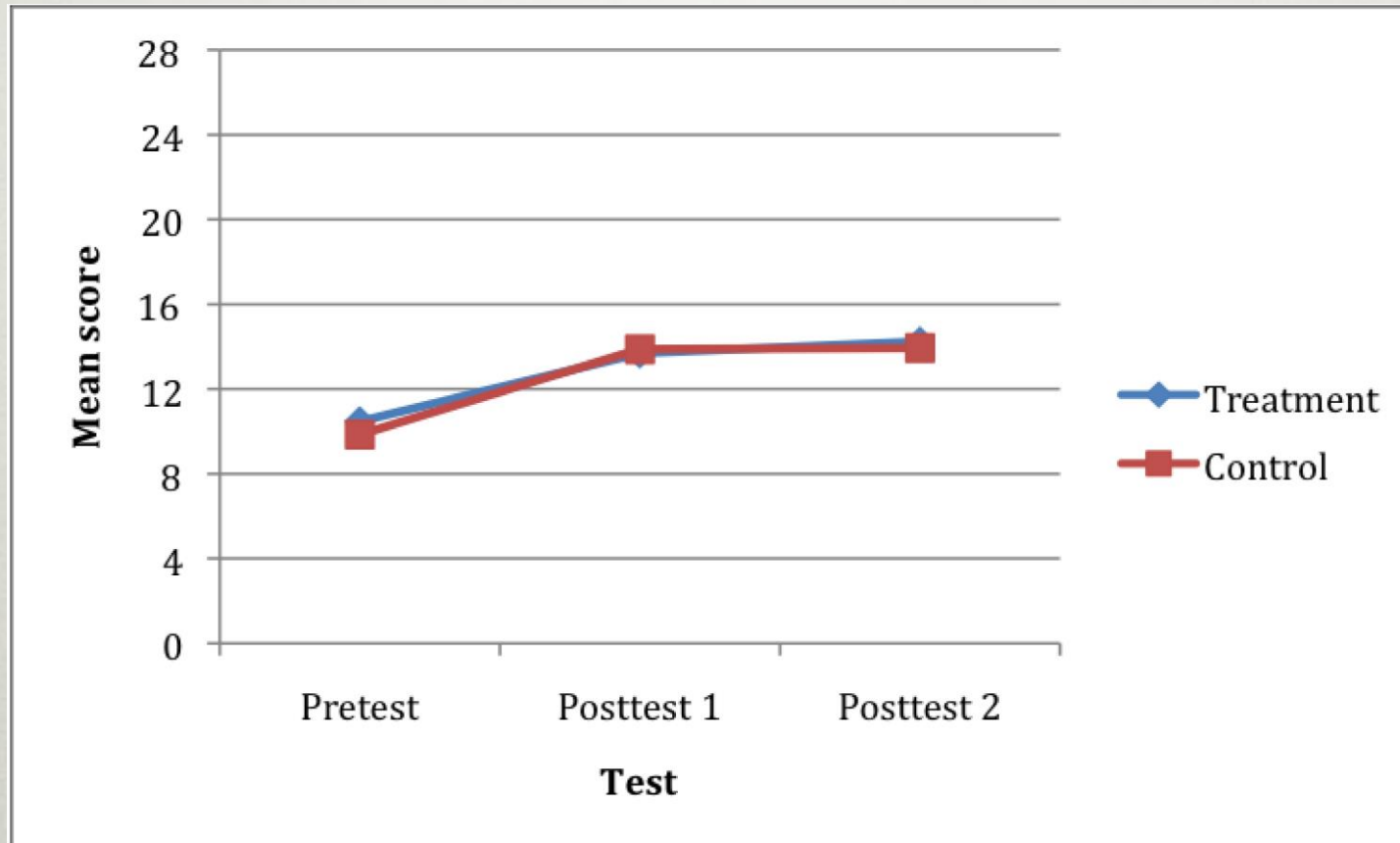
ethics.utah.edu/units...rugs/mouse.cfm

הקטטורמה כבר כאן!



RCT Studies on GSLC Modules

- *Amazing Cells* vs. standard instructional materials, including microscope lab (n=135)



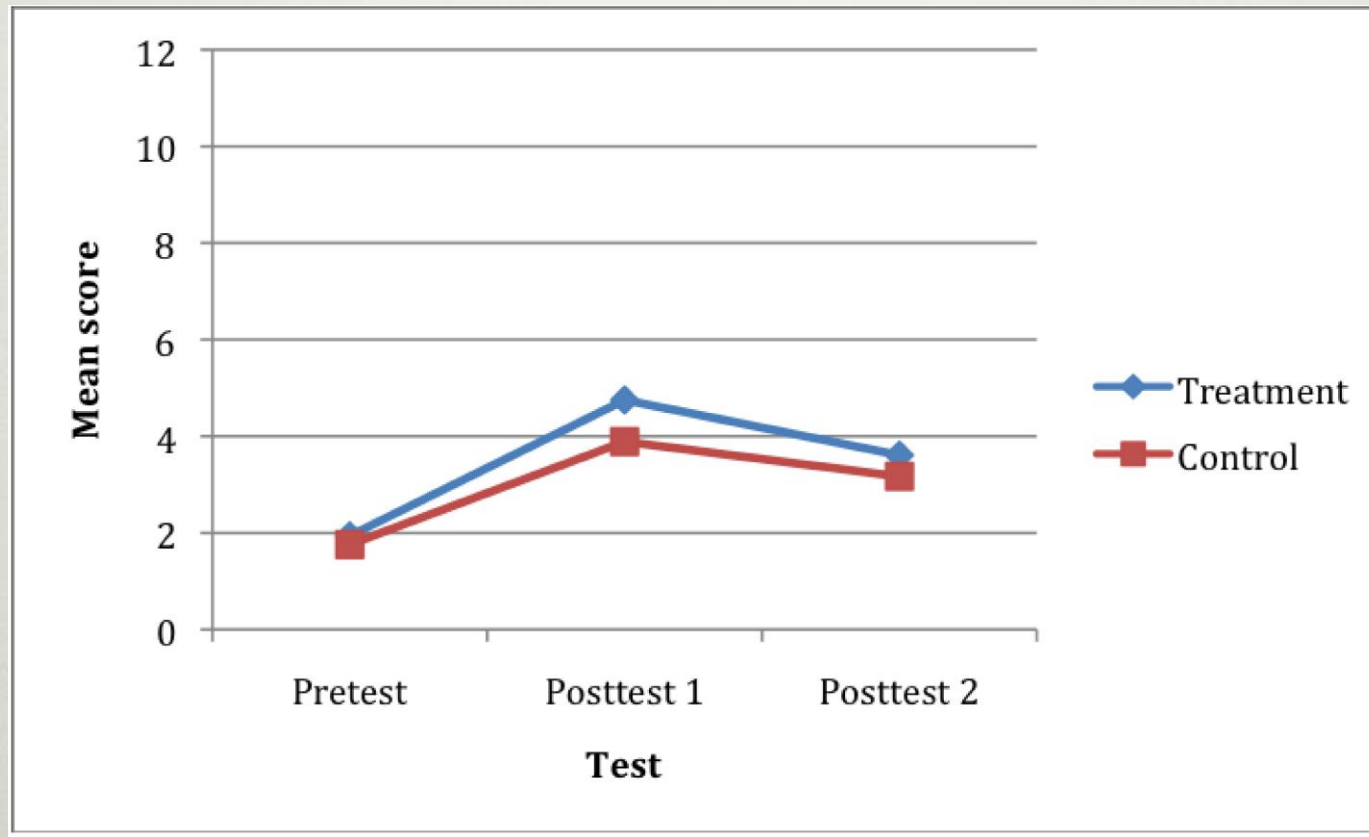
Significant difference pre/immediate post: $p < 0.001$

Cost: GSLC \$0; standard \$214



RCT Studies on GSLC Modules

- *Epigenetics* vs. NOVA scienceNOW; both multimedia & hands-on model (n=137)



Significant difference pre/immediate post: $p < 0.001$

GSLC vs NOVA: $p < 0.05$

Cost: GSLC \$0; NOVA \$42

Other Evaluation Studies on GSLC Modules

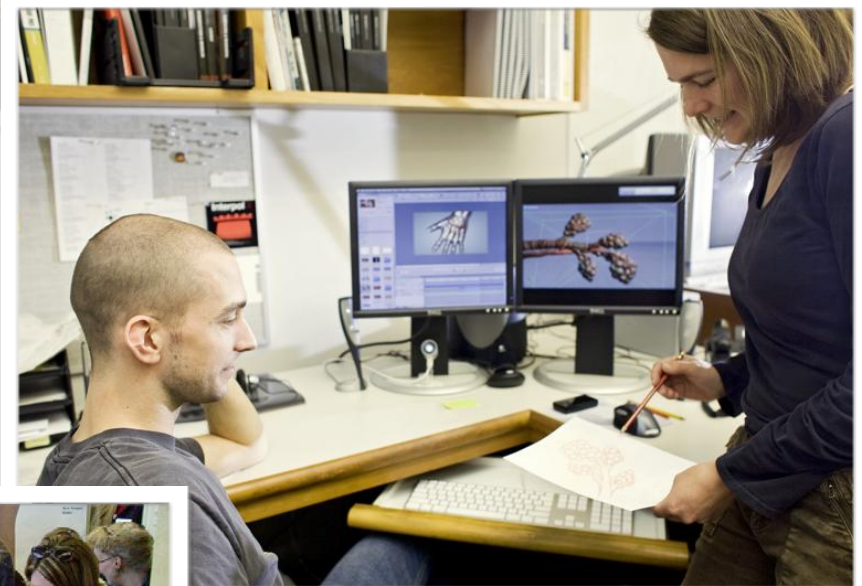
- Studies on 8 other GSLC modules (n=400-500 students/module)
- Students showed significant learning gains ($p < 0.01$ or $p < 0.001$, depending on module)

Teacher Implementation Study

- Online surveys about *Amazing Cells, Cloning, & Epigenetics*
 - 1,024 educators, grades 4-12 & postsecondary
 - HS teachers most common; 1/5th outside US
 - Almost all LCD projector & student computers
 - Used Learn & Teach materials together
 - Used Interactive Explore activities most
 - Used activities giving general overview most
 - Used materials to supplement instruction

Teacher Implementation Study

- Interactive Explore activities typically projected to whole class
- >1/2 of teachers adapted Print-and-Go activities to fit students' needs (reading level or student knowledge)
- Some teachers used Print-and-Go activities independent of online Learn materials
- Constraints:
 - Time to explore modules
 - Fitting state standards
 - Appropriate difficulty level for students



Genetic Science Learning Center Team



NIH Funding

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NIDA
NATIONAL INSTITUTE
ON DRUG ABUSE

SEDAPA Science Education Drug Abuse
Partnership Award
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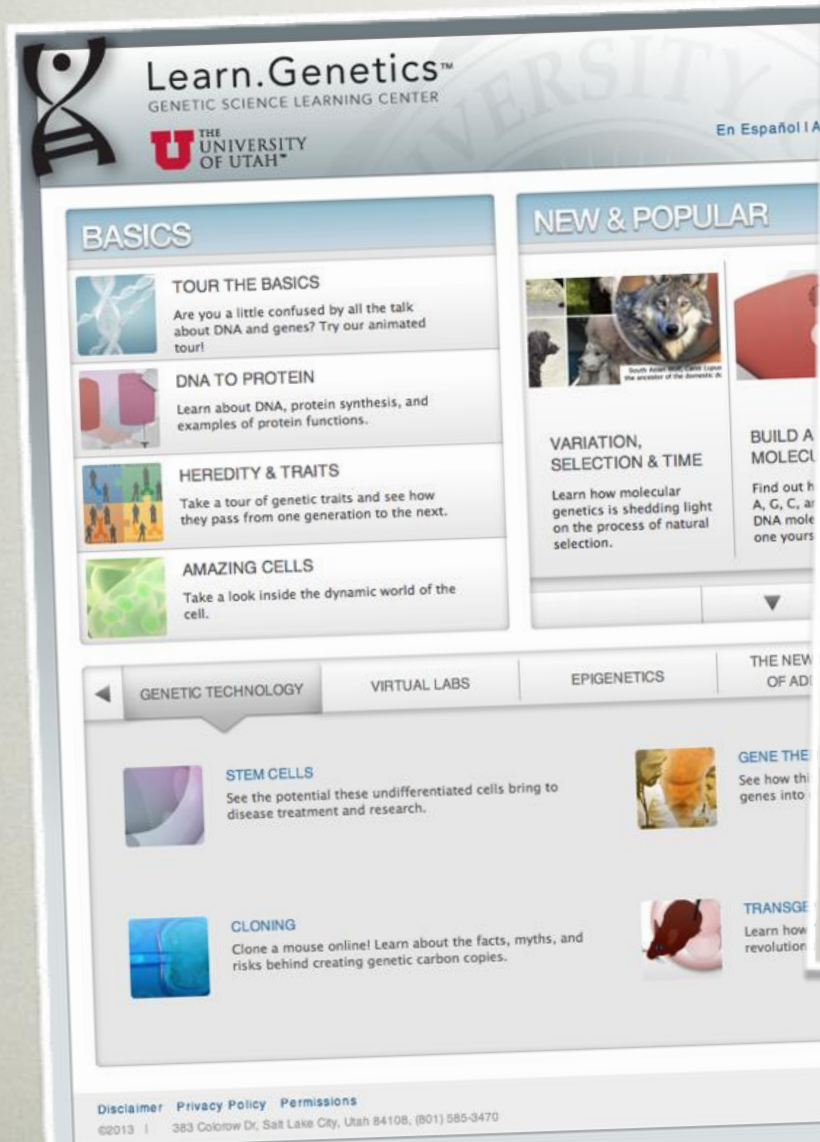
National Human
Genome Research
Institute



National Institute
of Allergy and
Infectious Diseases



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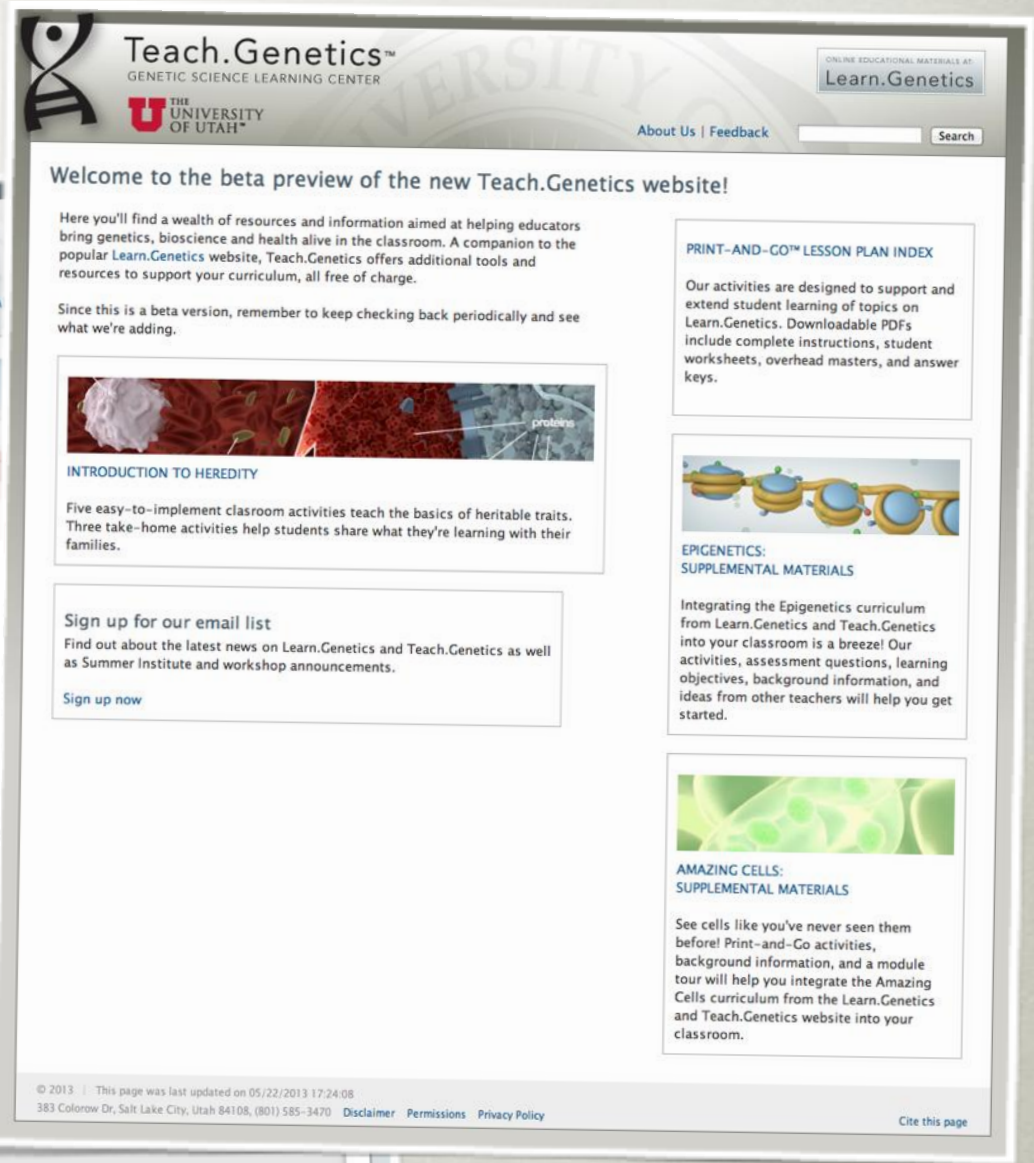
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- TRANSGENIC**
Learn how genetic engineering is revolutionizing agriculture.

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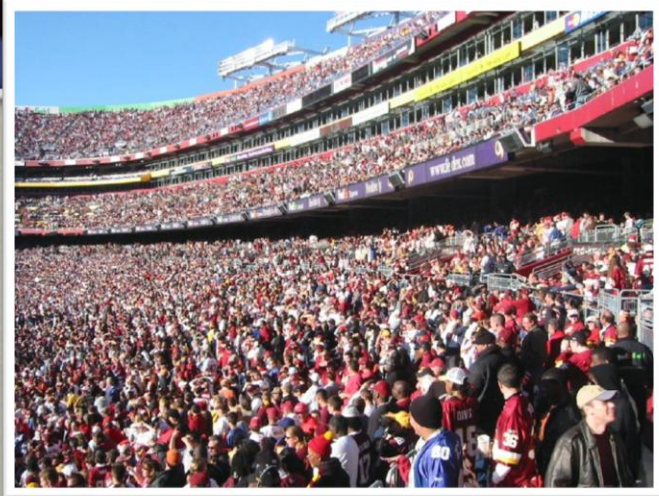
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Learn.Genetics & Teach.Genetics

- Over 18 million visits in 2012
 - 900,000 visits in 2001 (NIH funding began)
- Over 47 million page views in 2012
- In top 99.995 percentile of most used websites

FedEx Field



Verizon Center



Stem Cells

STEM CELLS



explore THE NATURE OF STEM CELLS

Stem cells play many important roles in our bodies from embryonic development through adulthood.



interactive explore GO, GO, STEM CELLS

Send activating signals to stem cells and watch them get to work!

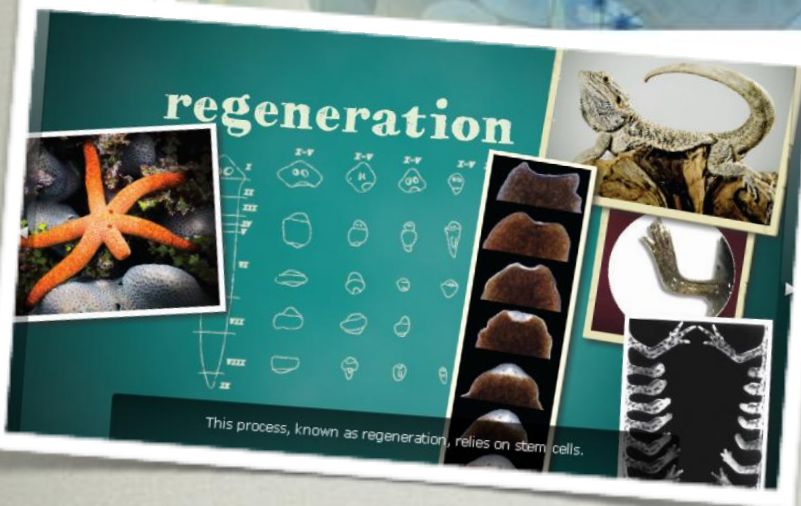
learn more STEM CELLS IN USE

Stem cell therapies have been curing diseases for decades.

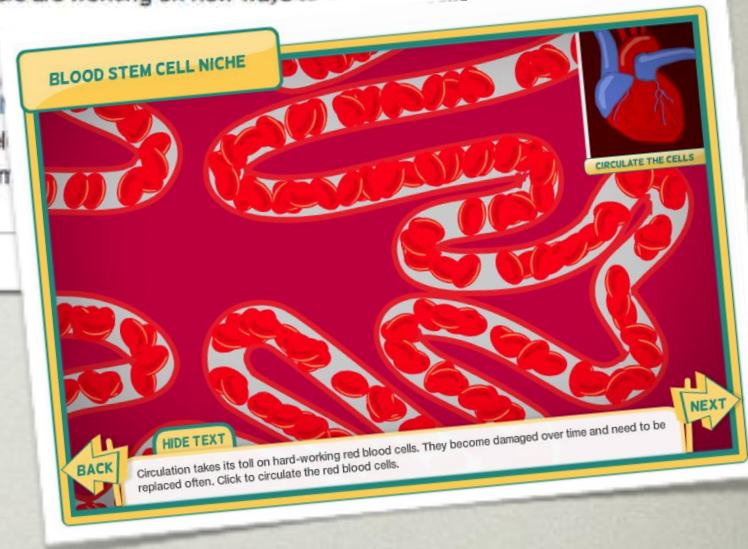
explore UNLOCKING STEM CELL POTENTIAL

Researchers are working on new ways to use stem cells in medicine.

learn more
THE STEM
New devel
about stem



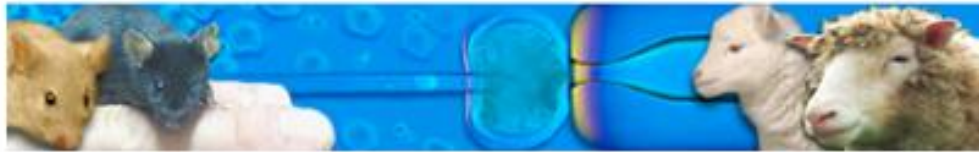
tial for treating diseases.



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Cloning

CLONING



interactive explore WHAT IS CLONING ?

An introduction to cloning and how it's done.



interactive explore CLICK AND CLONE

Try it yourself in the mouse cloning laboratory.

ADDITIONAL RESOURCES

Links to current news and in-depth information about cloning.

acknowledgments

interactive explore THE CLONE ZONE

Explore the history of cloning

interactive explore IS IT CLONING ? OR NOT

Test your cloning savvy with

learn more WHY CLONE ?

Evaluate the reasons for using cloning technologies.

learn more CLONING MYTHS

Separating the facts from the fiction.

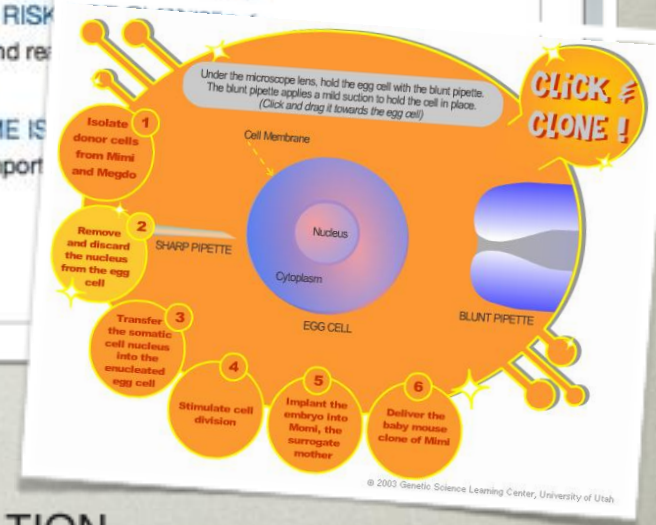
learn more WHAT ARE THE RISKS

The predictions and

learn more WHAT ARE SOME ISSUES

Consider some important

technologies.



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Gene Therapy

GENE THERAPY: MOLECULAR BANDAGE ?



[learn more](#)

WHAT IS GENE THERAPY ?

The what and why of gene therapy research.

[learn more](#)

CHOOSING TARGETS FOR GENE THERAPY

See how researchers decide which disorders are appropriate for gene therapy.

[learn more](#)

GENE DELIVERY: THE KEY TO GENE THERAPY

Putting therapeutic genes into cells is easier said than done. Find out why.



[interactive explore](#)

TOOLS OF THE TRADE

Explore the methods for delivering genes into cells.



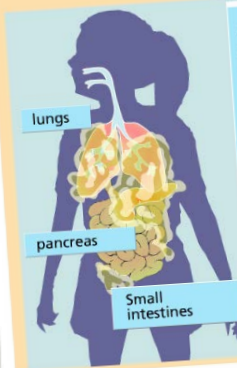
[interactive explore](#)

SPACE DOCTOR

You are the doctor! Design and test gene therapy.

Gene Therapy Case Study: Cystic Fibrosis

BB 4 4 MM



Since all of the cells of a CF patient have the defective protein, large quantities of thick, sticky mucus build up throughout the lungs and other organs. This results in the severity of symptoms seen in CF patients.

er cystic fibrosis and the
tial treatment.

ormation about gene

[learn more](#)

FROM RESEARCH TO TRIALS

How long does it take? Follow a gene therapy trial.

[learn more](#)

CHALLENGES IN GENE THERAPY

Why isn't gene therapy a smashing success?

[learn more](#)

NEW APPROACHES TO GENE THERAPY

Examine some up-and-coming techniques.

[learn more](#)

ENHANCEMENT: GENE THERAPY

Retrovirus!

(pronounced "RET-ro-VY-rus")

Retroviruses are a group of viruses that carry their genetic material in the form of RNA rather than DNA. The most famous retrovirus is Human Immunodeficiency Virus (HIV), which causes AIDS.

TYPE
Viral Vector

TARGET

Retroviruses infect only dividing cells, so they cannot target cells that have stopped dividing. It is possible to target specific cell types by engineering proteins on the virus surface to recognize special proteins on the target cell's surface.

The maximum length of RNA that can be inserted into a retrovirus is 8,000 base pairs (8 kilobase pairs).

ACTIVATION

Once a retrovirus infects a cell, its RNA travels to the cell's nucleus. However, the virus's RNA-based genetic material must be converted to DNA before some genes are activated. The retrovirus contains enzymes that do this job.

INTEGRATION

The DNA made from the virus' RNA template integrates into the host cell's genome in random locations. Once integrated, it will be duplicated along with the rest of the DNA when the cell divides.

SIDE EFFECTS

Since the retrovirus genome integrates randomly into a cell's genome, there is the chance that it will integrate into a place where it disrupts another gene. This may affect the cell's ability to divide properly, possibly causing tumor growth.

Retroviruses can cause an immune response in the patient. You can reduce this possibility by removing proteins on the surface of the virus that trigger the response.



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Personalized Medicine

PERSONALIZED MEDICINE (PHARMACOGENOMICS)

Why do people vary in their responses to prescribed medications, both with respect to how well it works and adverse reactions to it?

Researchers think the answer lies in our genes.

Scientists, physicians and the pharmaceutical industry are actively developing ways to customize medical treatments to suit our unique genetic signatures. The study of how genetic variations interface with drug response and disease risk is called pharmacogenomics.



interactive explore
YOUR DOCTOR'S NEW GENETIC TOOLS

Investigate a pharmacogenetic test that is being used in the clinic today.

learn more
MAKING SNPs MAKE SENSE

See how tiny variations in a person's DNA make-up can help predict drug response or disease risk.



interactive explore
PUS-POPPIN' FROGS

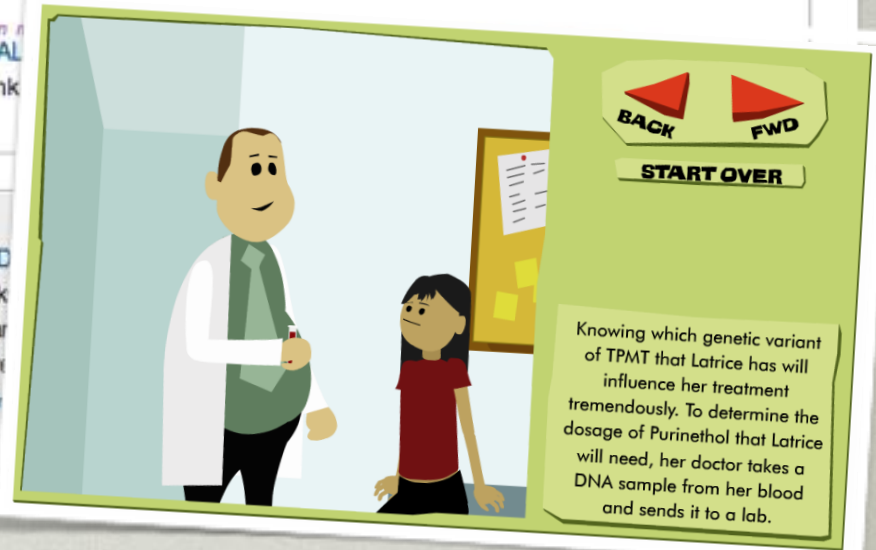
You are the researcher! Use single nucleotide polymorphism (SNP) data to prescribe medications for frogs with bad skin.

learn more
DRUG DEVELOPMENT TODAY AND TOMORROW

Consider how pharmacogenetics might remake the drug development process.

learn more
CHALLENGES
Think

ADD
Link
phar
cov
ack

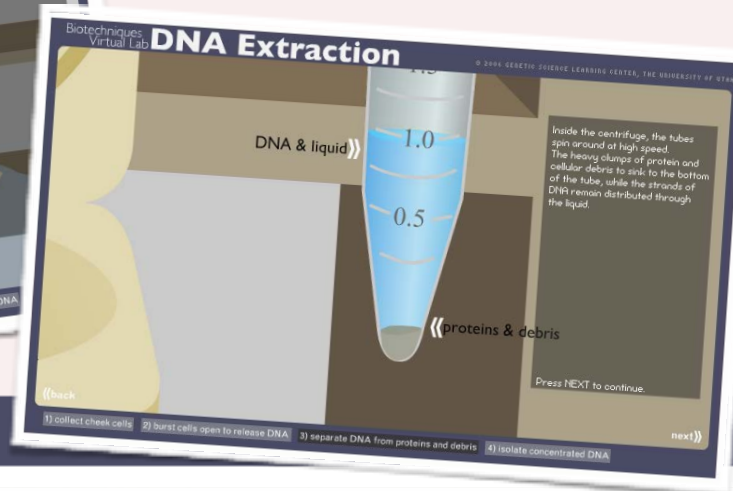
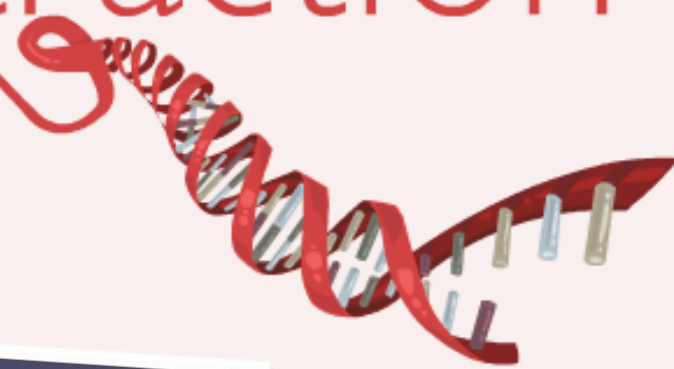


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DNA Extraction Virtual Lab

© 2006 GENETIC SCIENCE LEARNING CENTER, THE UNIVERSITY OF UTAH

DNA Extraction Biotechniques Virtual Lab

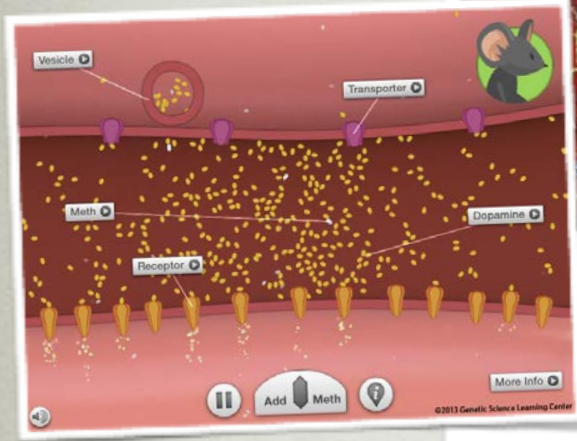


start lab»»

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The New Science of Addiction

The New Science of Addiction: Genetics and the Brain



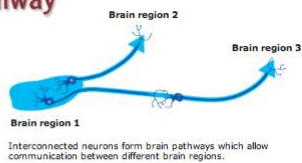
Drug addiction is a chronic disease characterized by changes in the brain which result in a compulsive desire to use a drug. A combination of many factors including genetics, environment and behavior influence a person's addiction risk, making it an incredibly complicated disease. The new science of addiction considers all of these factors - from biology to family - to unravel the complexities of the addicted brain.



Beyond the Reward Pathway

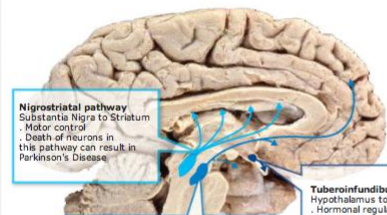
What Is a Brain Pathway?

You can think of a brain pathway as a power line that connects two brain regions. Brain pathways are made up of interconnected neurons along which signals are transmitted from one brain region to another.



The Dopamine Pathways

Dopamine is the neurotransmitter used by the reward pathway (also called the mesolimbic pathway, which is closely associated with the mesocortical pathway). But there are two other important pathways in the brain that utilize dopamine: the nigrostriatal pathway and the tuberoinfundibular pathway. Generally, drugs that affect dopamine levels in the brain affect all three of these dopamine pathways.



Tuberoinfundibular pathway
Hypothalamus to Pituitary gland
• Hormonal regulation
• Maternal behavior (nurturing)
• Pregnancy
• Sensory processes

Mesolimbic and Mesocortical pathways
Ventral Tegmental Area to Nucleus Accumbens, Amygdala & Hippocampus, and Prefrontal Cortex
• Memory
• Motivation and emotional response
• Reward and desire
• Addiction
• Can cause hallucinations and schizophrenia if not functioning properly

The Few Rule the Many

Dopamine and another neurotransmitter called Serotonin are released by a small number of neurons in the brain. But each of these neurons connects to thousands of other neurons. For this reason, dopamine and serotonin have a great deal of influence over complex brain processes.

The Serotonin Pathways

Pathways Exist in the Brain

responsible for driving our feelings of behavior.

[Learn More](#) ☐ ☐ ☐
[Take a Closer Look](#)
[The Other Brain Cells](#)

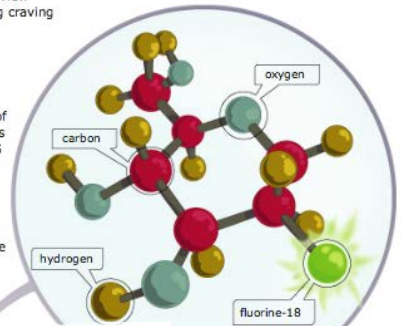
Brain Imaging Technologies

Modern brain imaging techniques like PET and MRI (Magnetic Resonance Imaging) are becoming indispensable to researchers studying addiction and its effects on the brain. That is because addiction research requires looking inside the brain at areas where both drugs and natural chemicals act. Researchers can now determine how quickly drugs reach receptors in the brain and how long they stay there. Or, view changes in brain activity after long-term drug use, during craving or withdrawal, or following various treatments for drug abuse and addiction.

Choosing a Compound

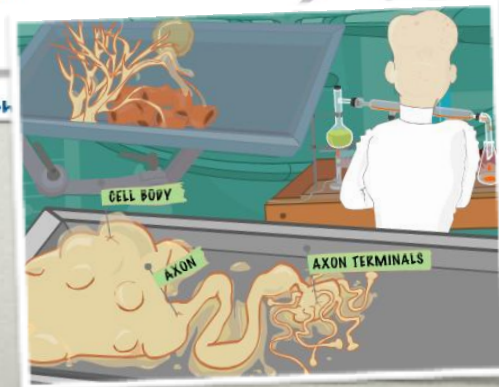
Before a PET scan begins a patient is given a safe dose of a radioactive compound. If the purpose of the PET scan is to study brain activity, doctors and scientists choose FDG (fluorodeoxyglucose), which is a modified glucose molecule.

Glucose is a type of sugar, and it is the main energy source for the brain. The injected or inhaled FDG will enter the person's bloodstream, where it can travel to the brain. If a particular area of the brain is more active, more glucose or energy will be needed there. The more glucose is used, the more radioactive material is absorbed.



Drugs Alter the Brain's Reward Pathway

NIDA
NATIONAL INSTITUTE
ON DRUG ABUSE



Amazing Cells

AMAZING CELLS

CELLS ARE COMPLEX & DYNAMIC

The cell's interior is structured in a way that streamlines cell function.



[Interactive explore](#)
GO INSIDE A CELL

See the parts of a cell in action.

CELLS COMMUNICATE

Cells communicate through signals, aided by pathways made mostly of proteins. A cell's response depends on the signal itself, as well as the cell type.

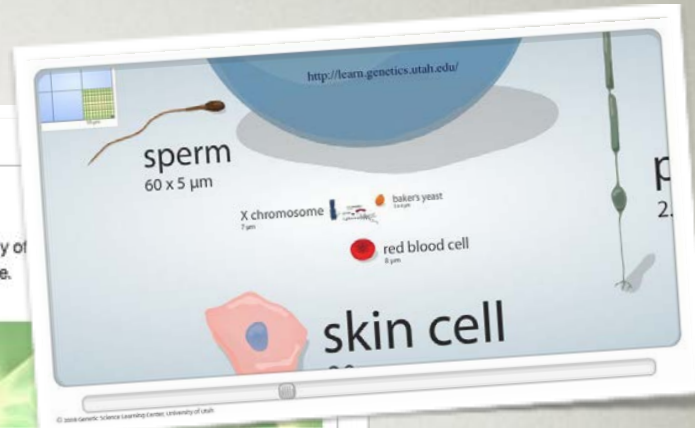


[3D animation](#)
**AN EXAMPLE OF CELL COMMUNICATION:
THE FIGHT OR FLIGHT RESPONSE**

When the brain detects danger or a threat, cell signaling machinery springs into action, producing a variety of responses throughout the body.

[learn more](#)
**HOW CELLS COMMUNICATE DURING THE
FIGHT OR FLIGHT RESPONSE**

An in-depth look at one axis of cell communication during the fight or flight response.



[Interactive explore](#)
DROPPING SIGNALS

Cell signals travel through the body, coming in contact with many cell types. The response depends on the type of cell the signal reaches.

[learn more](#)
**WHEN CELL COMMUNICATION GOES
WRONG**

Cell communication can be disrupted in a number of ways, sometimes resulting in disease.

[learn more](#)
**THE INS
COMMUNICATING**
How signals



**FIG: HOW VESICLES
GO**
Vesicles called vesicles carry materials

ORGANIZE CELLULAR
Structure is essential for organized and efficient

CELLS IN PERSPECTIVE

In 1665, Robert Hooke coined the term cell to describe the structures he could see in cork with some of the first microscopes. Since then, technology has given us an increasingly complex view of the basic unit of life.



[Interactive explore](#)
CELL SIZE AND SCALE

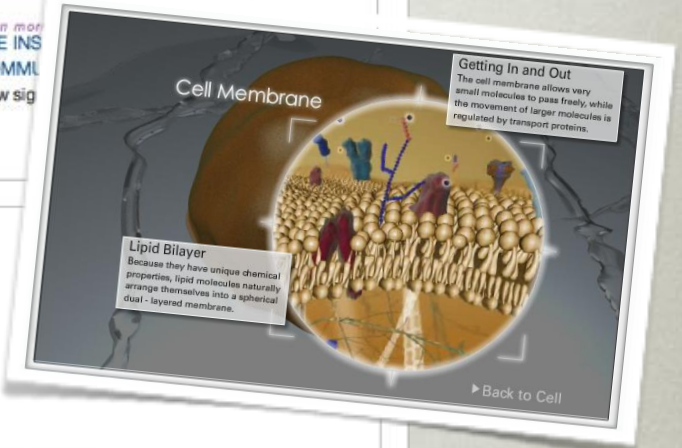
How big are cells compared with other objects, molecules and atoms?

[learn more](#)
THE EVOLUTION OF THE CELL

The endosymbiotic theory explains how relatives of ancient bacteria ended up in modern-day cells.

[links to other sites](#)
REAL CELL VIDEOS

Links to real cell videos and images on the Internet.



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Epigenetics

EPIGENETICS

WHAT IS EPIGENETICS?

The development and maintenance of an organism is orchestrated by a set of chemical reactions that switch parts of the genome off and on at strategic times and locations. Epigenetics is the study of these reactions and the factors that influence them.



introductory video

THE EPIGENOME AT A GLANCE

An introduction to the epigenome and how it instructs DNA.

interactive explore

GENE CONTROL

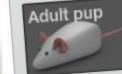
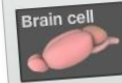
Change the level of gene expression in a cell with the turn of a dial

learn more

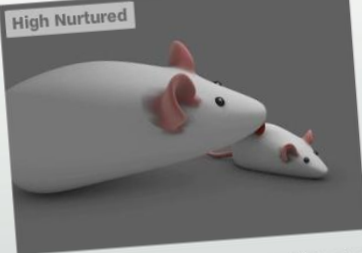
THE EPIGENOME AT A GLANCE



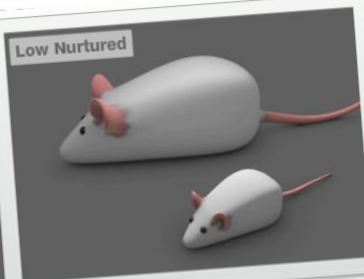
Mom



Adult pup



These mothers come from a long line of inbred rats, so their genomes are highly similar. But they care for their pups very differently.



AUDIO

Click a rat pup:

GO!

EPIGENETICS & THE ENVIRONMENT

The genome dynamically responds to behavior, toxins and other factors that regulate gene expression.



video explore

INSIGHTS FROM IDENTICAL

Why do the physical characteristics of identical twins diverge as they age? Follow the interaction of the environment and the genome in a pair of twins over time.

interactive explore

LICK YOUR RATS

What kind of mother are you? Care for a rat pup and shape its epigenome.

learn more

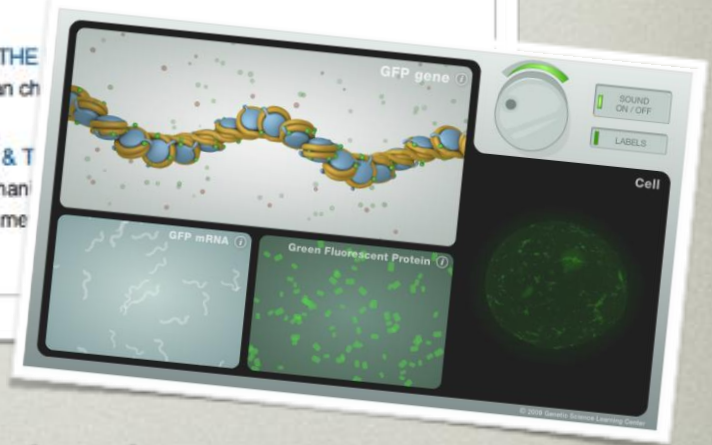
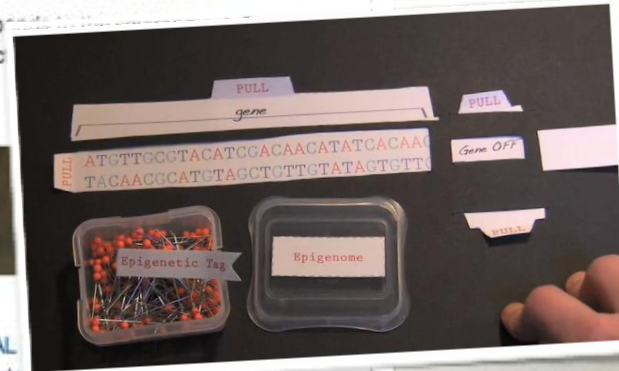
NUTRITION & THE

What you eat can change

video learn more

EPIGENETICS & T

Epigenetic mechanisms function and in me



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NHGRI DNA Day Presentation Materials

Genomics Research Will Not Yield "Designer Babies"

"We'll get closer to perfect kids from caring families and good education than we'll ever get from genetics."

- Francis S. Collins, M.D., Ph.D., Special Volunteer and Former Director, NHGRI

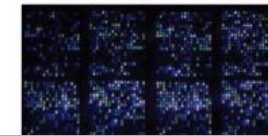
- Most traits are controlled by many genes and the environment



Current research: Mapping out the timing and location of gene expression

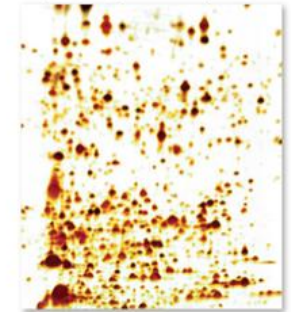
DNA Microarray Technology

Allows scientists to determine which genes are "on" or "off" in a particular cell type

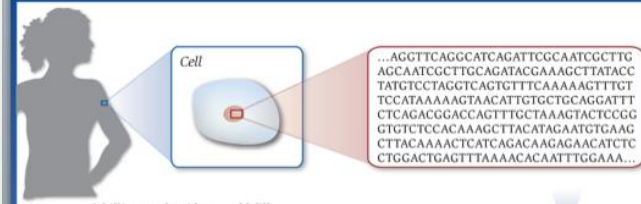


Protein Expression Analysis

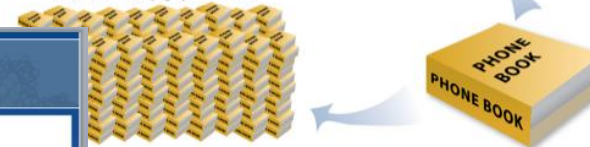
Allows scientists to determine which proteins are present in a particular cell type



The human genome contains about 3 billion nucleotides



3 billion nucleotides would fill about 200 1,000-page phone books

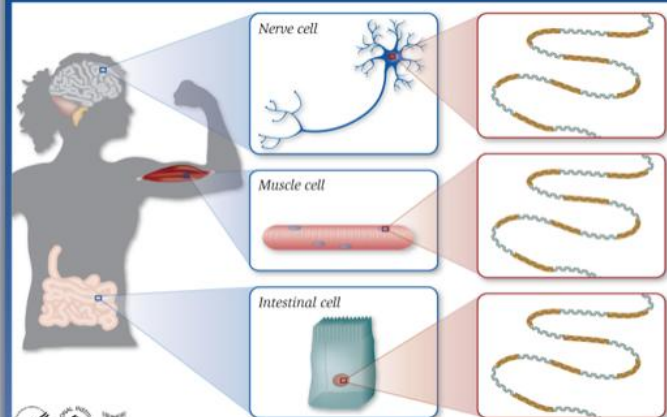


National Human Genome Research Institute

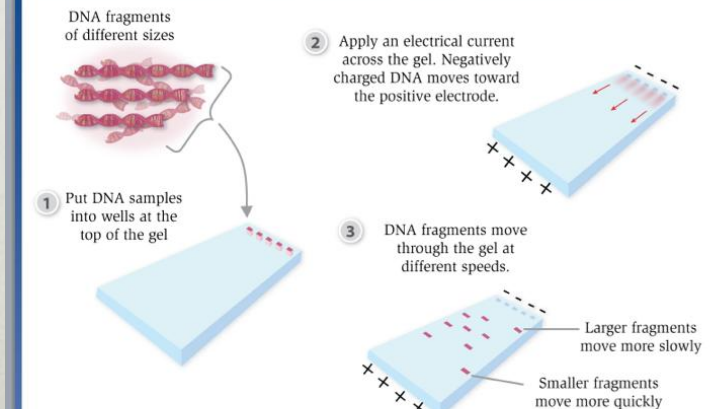
Polymerase Chain Reaction (PCR)



All of the cells within an individual contain the exact same genetic information

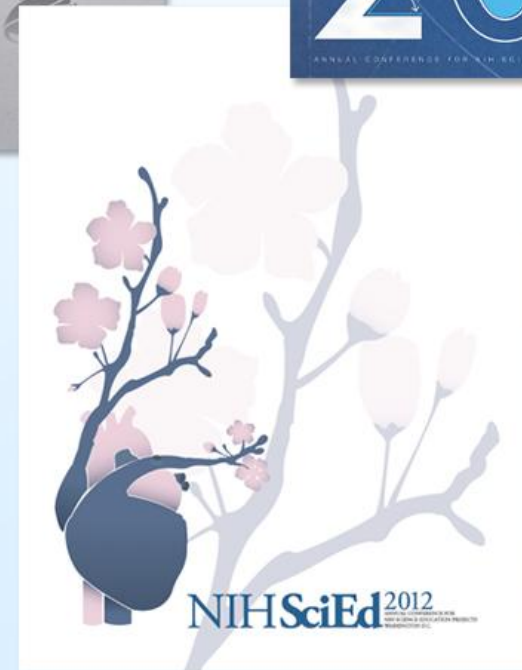


Gel electrophoresis



NHGRI Community Genetics Forum





SEPA and NIH SciEd Conferences

In Production

- Human Microbiome
 - NIAID
- Learning, Memory & Multitasking
 - SEPA
- Neuroscience of Our Senses apps
 - NIH Blueprint for Neuroscience Research
 - Science Education Awards
- Food to Fuel
 - SEPA

Other Funding

HHMI



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of Health

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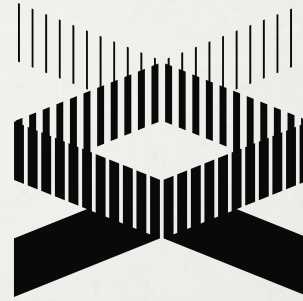
U.S. Department of Health and Human Services
HRSA
Health Resources and Services Administration

NIH Funding

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NIDA
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National Human
Genome Research
Institute



National Institute
of Allergy and
Infectious Diseases

