



Purpose

The resources provided in this document are not required to be used in preparation for your lab. They are simply resources that we thought might be helpful to you and engaging for your students. It is your choice to use them and you may pick as few or as many to implement as you like.

**If you are receiving a Title I scholarship for your lab, you are required to implement a vocabulary or journal activity prior to your lab visit.*

Grade Levels 6-12	Lab Summary This lab introduces your students to DNA, the blueprint for life, and allows them to spool and view real DNA from animal cells. Students will also explore their own genes through an exercise in dominant and recessive traits.	Student Outcomes Students will: <ul style="list-style-type: none"> • Provide evidence that living things are made of cells by examining their own cheek cells. • Explain the difference between dominant and recessive traits in classic Mendelian genetics.
	Common Core Language Arts Standards <i>Speaking and Listening</i> Grade 6: SL.6.1b-d Grade 7: SL.7.1b-d Grade 8: SL.8.1b-d Grades 9-10: SL.9-10. 1b-d Grades 11-12: SL.11-12.1b-d	

State and National Standards Connections

Next Generation Science Standards

	Life Science	Disciplinary Core Ideas	Crosscutting Concepts	Science and Engineering Practices
Grades 6-8	MS-LS1-1 MS-LS1-3	LS1.A LS3.A LS3.B	Structure and Function Cause and Effect	2, 3
Grades 9-12	HS-LS1-1 HS-LS3-1 HS-LS3-3	LS1.A LS3.A LS3.B	Structure and Function	2, 3



Preparing for the Lab Experience

There are many ways to help prepare your students before the lab and help them reinforce their knowledge after the lab, including the content you are covering in the classroom. Below you will find a chart of some materials we offer to help support your classroom.

	Description	Recommended	Time, Materials & Support Needed
Lab Journal	Includes: <ul style="list-style-type: none"> • Vocabulary • Pre- and post-journal • Venn diagram • Tech Interactive notes & connections • Questions about the lab 	<ul style="list-style-type: none"> • Pre-lab activities • Activities during field trip • Post-lab activities • Vocabulary definitions and journal prompts provided in this resource guide* 	<ul style="list-style-type: none"> • 5-60 minutes (1+ days) • Print the journals • Assemble the journals • Writing utensils
Lab Related Activities			
Dino DNA	Through this activity, pairs of students will play with dominant and recessive alleles to create a new creature.	<ul style="list-style-type: none"> • Post lab activity 	<ul style="list-style-type: none"> • 30-45 minutes
Nature or Nurture	In this activity, students are asked to think of a trait that has been passed down in their family and to generate a stance on whether they think this is a genetic trait, something that individuals develop as part of the family environment, or some combination.	<ul style="list-style-type: none"> • Pre-lab with vocabulary support and basic introduction to traits. • Post-lab to reinforce which traits are genetic and how they are passed on. 	<ul style="list-style-type: none"> • 15-30 minutes
Who has the Gene?	Through this activity, your students will be able to test their family for the PTC taster gene and compare to themselves.	<ul style="list-style-type: none"> • Post-lab activity 	<ul style="list-style-type: none"> • 20 minutes • Specialized materials: <ul style="list-style-type: none"> • PTC paper strips and worksheet (provided by The Tech during the lab)



Related Links and Games

The following links and games provide additional information about genetics and inheritance. We are not endorsing the following organizations, but feel that the information may be of benefit to your students and may help enhance the learning experience of the lab.

- **Time.com: The Genetics Revolution:** This site provides the most current news articles dealing with genetics. *We recommend examining the articles first before directing students here as some articles may be inappropriate for your students' age level. <http://time.com/tag/genetics/>
- **National Human Genome Research Institute:** This site has a lot of great teacher and student resources for all things genetics, including the Human Genome Project, information on genetics careers, fact sheets, vocabulary terms (English and Spanish), articles and more. <http://www.genome.gov/Education/>
- **University of Utah Genetic Science Learning Center:** This site has many genetics resources including interactive explorations, videos and virtual tours of genes. <http://learn.genetics.utah.edu/>
- **Toothpick Fish activity:** This is a great activity to study genetics and natural selection in the context of an environmental disaster. <http://eeinwisconsin.org/content/eewi/101364/toothpickfish.pdf>
- **Genetics Home Reference:** This site provides information on genetic conditions as well as a glossary of terms and other resources to find out more about genetic conditions. <http://ghr.nlm.nih.gov/>
- **DNA — The Double Helix:** Play this interactive game to test your knowledge on proper base pair matching and DNA comparison! https://educationalgames.nobelprize.org/educational/medicine/dna_double_helix/dnahelix.html
- **Highlight a Geneticist:** This site provides information on different scientists that added to or changed our understanding of genetics. <https://www.thefamouspeople.com/geneticists.php>

Related Texts

The following titles may provide students with a greater contextual understanding of the field of DNA and genetics. Included in the list are narratives (fiction/nonfiction), referential texts and books that extend learning beyond the scope of the lab. We are not endorsing the following authors, but feel that the information may be of benefit to your students and may help enhance the learning experience of the lab.

Narratives

- "Jurassic Park." By Michael Crichton.
 - Recommended for grades 7-12,
 - An astonishing technique for recovering and cloning dinosaur DNA has been discovered and the plan is to recreate these extinct creatures so that the world can visit them – for a price. Until something goes wrong...
- "The Stuff of Life: A Graphic Guide to Genetics and DNA." By Mark Schultz.
 - Recommended for grades 9-12,
 - "A complete introduction to the history of genetics that's easy to understand as it is entertaining to read." (Amazon)
- "Gregor Mendel: The Friar who Grew Peas." By Cheryl Bardoe. Illustrated by Jos. A. Smith.
 - Recommended for grades 3-6,
 - A picture-book biography on Gregor Mendel, the friar who conceived and put into practice the pea experiment to determine heredity and the notion of genes.

Reference

- "Have a Nice DNA (Enjoy your Cells)." By Frank Balkwill. Illustrated by Mic Rolph.
 - Recommended for grades 2-6,
 - One in a series of books that uses a unique brand of simple but scientifically accurate commentary and



colorful graphics to lead readers on an exploration of the world of cells, proteins and DNA.

- “Science Quest: Double Helix: The Quest to Uncover the Structure of DNA.” By Glen Phelan.
 - Recommended for grades 5-8.
 - A brief but informative view of the quest to understand the structure of DNA. It traces the story from Gregor Mendel and his pea plants to Crick and Watson.
- “Decoding Life: Unraveling the Mysteries of the Genome (Discovery!).” By Ron Fridell.
 - Recommended for grades 5-8.
 - An informative book about the stuff of life that uses good academic vocabulary and illustrations that support visual learners.
- “High-tech Harvest: A Look at Genetically Engineered Foods.” By Elizabeth L. Marshall.
 - Recommended for grades 7-10.
 - An overview of genetically engineered foods that explains DNA technology, genetic engineering and the techniques that are used to create crop plants and farm animals with desirable/attractive characteristics.
- “Basher Science: Biology: Life As We Know It!” By Dan Green.
 - Recommended for grades 4-12.
 - “Imagine life itself as a community of cool characters who keep our bodies and planet buzzing with activity. This book opens the doors and welcomes you into their amazing world.” (www.basherbooks.com)
A creative and quick introduction to the field of biology.

Extensions

- “The Genomics Age.” By Gina Smith.
 - Recommended for grades 7-12.
 - The book explores the recent leaps in the understanding of DNA through the use of scientifically informative, yet easy-to-understand plain English. It covers how discoveries in the field of DNA and genetics might change our lives and investigates the social, moral and ethical questions that accompany topics such as anti-aging, stem cell research, and “designer” babies. Easily select chapters for study or read the whole thing.
- “How to Clone a Mammoth: The Science of De-Extinction.” By Beth Shapiro.
 - Recommended for grades 9-12.
 - Could extinct species, like mammoths and passenger pigeons, be brought back to life? The science says yes, and Beth Shapiro shows you how. This is the science behind engineering extinct traits from the genetic “blueprints” collected and mapped from remains.
- “Brutes or Angels: Human Possibility in the Age of Biotechnology.” By Professor Emeritus James T. Bradley Ph.D.
 - Recommended for grades 9-12.
 - This is a guide to the rapidly progressing Age of Biotechnology. It provides basic information on a wide array of new technologies within the life sciences and raises the ethical issues associated with each. The ten biotechnologies considered: stem cell research, embryo selection, human genomics, gene therapies, human reproductive cloning, age retardation, cognition enhancement, engineering of nonhuman organisms, nanobiology and synthetic biology. Easily select the most interesting chapters or read the whole thing. A great resource for engaging students in conversations on the social impact and moral issues that often accompany scientific discovery.



Tech Interactive Gallery and Exhibit Connections

Biodesign Studio (Upper Level)

- *Living Colors Lab*: Engineer bacteria to grow in new colors never seen before!
 - Connection to the lab:
 - Students will use lab techniques to insert specially engineered DNA into safe E.coli bacteria, which will promote the bacteria to produce different colors under certain circumstances (different color genes, different amounts of promoter, varying environmental changes, etc.).
 - Students will have the opportunity to see DNA in action and how it can be used to engineer certain results. The techniques used in this activity are very similar to those that are used in science labs to produce insulin from non-human cells cultures.
 - Activities to complete at the exhibit:
 - Perform the activity presented in the gallery – all guidance is done by the augmented lab bench instructions and videos.
 - Questions to guide student learning:
 - Do you think we can engineer bacteria to do something beneficial to health? How?
 - How does the DNA get into the bacteria? How do you think the bacteria will respond?
 - What color(s) did you find? Has this color been found before?
 - Why do you think scientists would want to engineer a bacteria to do something other than what it does naturally? Why does DNA have to be involved in said process?
- *Creature Creation Station*: Mix and match a kit of tangible building blocks that represent real-world DNA parts with specific functions to explore how biological circuits are constructed.
 - Connection to the lab:
 - Students use tangible manipulatives that represent the three basic parts of DNA: a gene (what), RBS (how much), and a promoter (when). DNA pieces must be put together in the correct order (when-how much-what) or the DNA doesn't "work" to create the creature.
 - This activity will go a bit deeper into how DNA works and the different parts of DNA that make it functional.
 - Activities to complete at the exhibit:
 - Create a creature using the tangible DNA manipulatives.
 - Questions to guide student learning:
 - Can you use multiple genes in one piece of DNA? What about multiple promoters?
 - What happens if you put the pieces in the wrong order?



Design Challenge Learning Resources

Design Challenge Learning is a dynamic way for learners to become creative problem-solvers. The below link will take you to short guides created by educators at The Bowers Institute on facilitating design challenges, promoting engineering and fostering innovator mindsets.

<https://www.thetech.org/content/bowers-institute/resources>

Writing Prompts

The following writing prompts and questions are just a few examples of journal topics to incorporate writing into your students' lab experience. If you feel that one of the below prompts does not meet your needs, you are welcome to use your own, but please make sure it is related to the chosen lab experience. If you have a related writing prompt you would like to share with The Tech and other teachers, please let us know on our teacher survey that will be available in the lab.

Most of the writing topics could be used as either pre-lab or post-lab writing. You may choose the prompts that work best for your class and schedule.

Pre-Visit Writing Topics/Prompts

Generic

- We will be attending __lab name__ at The Tech Interactive; what do you think we will learn about in the lab? What do you want to know about this topic? What do you already know about this topic?
- We will be attending __lab name__ at The Tech Interactive; what are you looking most forward to in this lab? Why?

Specific to DNA and Genetics

- What is your favorite thing about yourself (personality, laugh, sense of humor, physical trait, etc.)? Do you think this is a genetic trait? Why? Do you see this trait in your parents? Siblings? Grandparents?
- If someone in your family was diagnosed with a genetic disease, would you have a genetic test to see if you could get the same disease? Why or why not?

Post-Visit Writing Topics/Prompts

Generic

- We learned a lot in our __lab name__ lab. What were your two favorite things you learned in the lab? Why?
- The principal is excited to hear all about your lab experience. Explain what you did and learned about in the lab since she or he was unable to attend the lab.

Specific to DNA and Genetics

- Since we now have the technology to use genetic fingerprinting to catch criminals, should we make every U.S. resident provide a blood sample for genetic fingerprinting to the government, making it easier to catch criminals? Write one paragraph explaining why this should happen and one paragraph explaining why this should not happen.
- All humans share approximately 99.9% of the same DNA. If we share this much, why do you think all people aren't more alike? Explain.



Pre-Visit Vocabulary

These are words and concepts that we will discuss in the lab. Your students' experience will be enhanced if they are familiar with these terms prior to your visit. Below you will find several graphic organizers and games to aid in your vocabulary review.

Terms and Definitions

Allele	An alternate form of the same gene or same genetic locus (location of specific gene).
Cell	The basic structural unit of all organisms.
Chromatin	A complex of DNA and protein found within the nucleus of a cell – condenses to form chromosomes.
Chromosome	Compact transportable structures composed of chromatin.
Dominant	One of a pair of alternative alleles that masks the effect of the other when both are present in the same cell.
DNA (deoxyribonucleic acid)	The genetic material of living organisms; makes up chromosomes of each cell; the “blueprint” or “recipe” for life.
Gene	The basic physical unit of heredity.
Genotype	The genetic make-up of an individual with particular emphasis on a particular gene (i.e., XX is the genotype for a female).
Nucleus	A large, membrane-bound structure within a living cell, containing the cell's hereditary material and controlling its metabolism, growth and reproduction.
Phenotype	The physical outcome/presentation of a genotype with emphasis on a particular gene. (Female is the phenotype for the genotype XX).
Phospholipid bilayer	A semi-permeable, two-layer membrane that comprises the cell membrane.
Punnett Square	A diagram used to predict the outcome and probability of genotype and phenotype of a breeding experiment.
Recessive	One of a pair of alternative alleles whose effect is masked by the activity of the second when both are present in the same cell.
Trait	A genetically determined characteristic or condition, like hair-color, dimples or sex.

Vocabulary Activities

Graphic Organizers

- *Frayer Graphic Organizer*: The Frayer Graphic Organizer is a great tool for vocabulary development. It allows students to write their own definitions, define characteristics, and provide examples and non-examples. This tool will lead your students to a deeper understanding of the vocabulary and how it relates to their lives. On page 10 you will find a blank Frayer Graphic Organizer for your use in the classroom.
 - For more information on the Frayer Model and how to implement it, please visit the following link: <http://www.theteachertoolkit.com/index.php/tool/frayer-model>
- *Vocabulary Graphic Organizer*: This graphic organizer is a great tool for younger students as well as English Language Learners. Although very similar to the Frayer Model, this graphic organizer includes a drawing of the vocabulary term and its use in a sentence. On page 11 you will find a blank Vocabulary Graphic Organizer for your use in the classroom.
- *Circle Map*: This graphic organizer is a great tool for helping all students develop an overall sense of a topic. It is also very helpful for beginning and early intermediate English Language Learners. This graphic organizer lets students brainstorm what a term or concept means to them and provides a frame of reference for the



term. On page 12 you will find a blank Circle Map for your use in the classroom.

- For more information on the Circle Map and other Thinking Maps, please visit the following link:
<http://thinkingmaps.com/why-thinking-maps-2/>

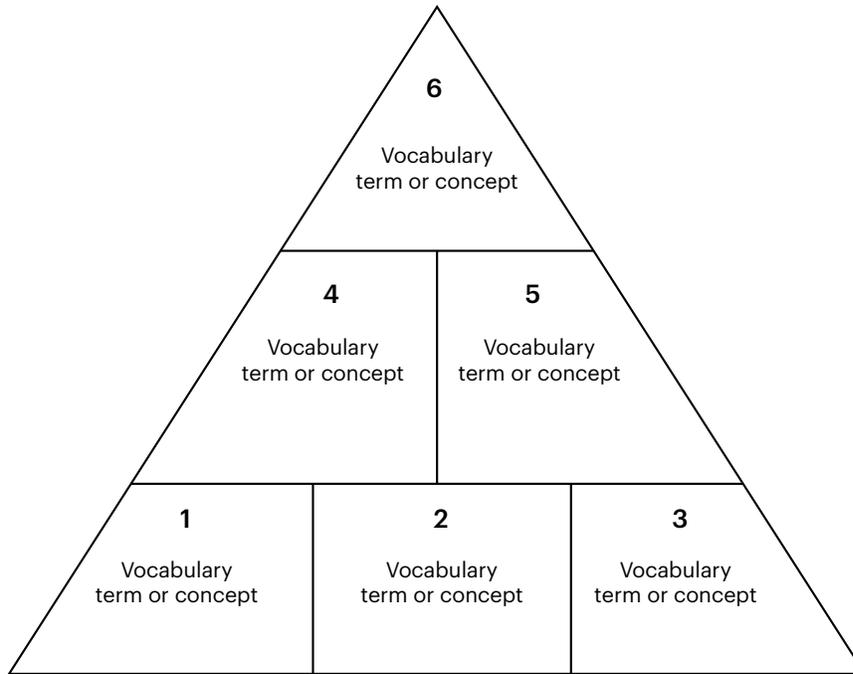
Vocabulary Review Games

- *Quiz, Quiz, Trade*: This is a fun cooperative game for students to review vocabulary terms. For more details and to see an example of Quiz, Quiz, Trade in action, please visit the following link:
<http://www.theteachertoolkit.com/index.php/tool/quiz-quiz-trade>
 1. Create questions or vocabulary cards. On one side of an index card, write the question or vocabulary term; on the other, the answer or definition. Pass out the cards to students. If there are not enough terms for everyone to have a different card, try using different “back” sides to the same cards (e.g., instead of the definition again, have a drawing, a question about the term, characteristics of the term or an example of the term).
 2. Pair up. When all cards have been passed out, students find a partner to quiz with their card.
 3. Hands up. When both partners have completed the quizzes correctly, they put their hand up to show other students that they are ready for a new partner to quiz.
- *Back-words*: This game is part Charades, part 20 Questions. In this review game, students have to guess the vocabulary term that is on their back by asking questions of a partner or having the partner act out the term.
 1. Write your vocabulary terms on index cards. If there aren't enough terms for each student to have a different one, you can make two sets and divide the class into two groups. You may also add in other related vocabulary terms that you have been studying in class.
 2. Tape one term onto the back of each student so that he or she cannot see the word.
 3. Have students pair up. Each partner should look at the word on their partner's back. Partners take turns asking questions or acting out or gesturing about the term that is on their back. (e.g., “Am I an element? Am I part of an atom? Do I make up all matter?”) Partners must ask at least two questions before guessing their word.
 4. When both partners have correctly guessed their word, they put a hand up to signal that they are in need of a new partner. Continue game play until everyone has guessed their word.
- *\$10,000 Pyramid*: This review game is exactly like the classic game show. Students will work in pairs, taking turns to describe the words and to guess the words.
 1. Break up the terms into two groups. Each partner will take on one group of words.
 2. Have each partner fill out the worksheet on the next page with their group of words.
 3. For the first round, Partner A will be the one describing the term and Partner B will be the one guessing the term. Partner A will describe the term (starting with 1) using the words he or she wrote down on the worksheet. From the description, Partner B will guess what the term is.
 4. When Partner B guesses the word correctly, Partner A moves on to the next word.
 5. When Partner B correctly guesses all the words in Partner A's pyramid, they switch places and Partner B will describe the terms on his or her pyramid while Partner A guesses the terms.
 6. You can time this activity like on the quiz show, but it may intimidate some students



Student Name: _____

\$10,000 Pyramid



Write descriptive clues about each vocabulary term or concept:

- 1. _____

- 2. _____

- 3. _____

- 4. _____

- 5. _____

- 6. _____



Frayer Graphic Organizer

Definition	Characteristics
Examples	Non-Examples

Vocabulary Word



Vocabulary Graphic Organizer

Definition	Characteristics
Sentence	Drawing

Vocabulary Word



Circle Map

