# DRIVING QUESTION: WHAT IS DNA?

**WELCOME LENGTH:** 1 hour

**OBJECTIVES:** Students will be able to:

- identify the primary components in a DNA structure
- describe the role of DNA in trait inheritance

## Standards:

*Next Generation Science Standards Addressed*

### Disciplinary Core Ideas

LS1.B Growth and Development of Organisms

LS3.A Inheritance of Traits

LS3.B Variation of Traits

### Practices

Asking Questions

### Cross-Cutting Concepts

Structure and Function: Complex and microscopic structures and systems can be visualized, modeled and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function.

## Materials:

- Copies of Lesson 1 Student Handout: Delicious DNA (1 per group of 2–3 students)
- Paper towels (1 per group of 2–3 students)
- *Licorice vines (2 per group of 2–3 students)
- Toothpicks (20 per group of 2–3 students)
- *Gummy candy in four colors (20 per group of 2–3 students)
- Optional: Student science textbook for additional information on DNA (1 per group of 2–3 students)

** You may wish to substitute fruit and/or vegetables for the candy options in the DNA model. The materials list suggests using licorice vines for the sugar phosphate backbone; gummy candies such as gummy bears, jellybeans or colored marshmallows for the bases; and toothpicks to connect components.*

## Suggested Video:

**"The Double Helix"** by BioInteractive

http://www.hhmi.org/biointeractive/double-helix (16:53)

*Note: Due to the length of this video, you may wish to show only a portion of the history of DNA research.*

## Lesson Context

This section provides guidance for teachers for how lessons build on each other.

"Bringing Biotechnology to Life" provides students a journey through the understanding of biotechnology with an emphasis on food production. Lesson one presents the foundational knowledge to build upon in regard to DNA's role in the inheritance of traits and variations of these traits over time. It all starts with the DNA structure discovery, as explained in the suggested video link, and how models played a vital role in the double helix discovery. Students will build their own DNA model during this lesson and get to eat it too!

**KEY CONCEPTS:** Before we can jump into a discussion about biotechnology, we must know how genetic information is passed from generation to generation. In eukaryotic organisms chromosomes are found in the nucleus of the cell. Chromosomes are made up of DNA. Genes on the double helix DNA structure contain genetic information, which will provide a blueprint for the characteristics/traits of the offspring. During meiosis, this information is passed from parent to offspring.

**SETUP:** Set out lab supplies and prepare copies of the student handout.

## Outline:

1. Draw three boxes on a whiteboard. Above the first box, draw a large pair of eyes. Above the second box, draw a movie slate board clapper. Above the third box, draw a question mark.
2. Ask students to think about what they already know about DNA. Help them "unpack" this knowledge by sorting concepts into three categories: what DNA looks like (eyes), what it does (clapper) and why we should care/significance of it (question mark). Solicit responses and capture information in each box.

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**LISTEN FOR THE FOLLOWING!**

- double helix, ladder, found in nucleus
- made up of genes that code for traits like eye color, hair color, height, etc.
- all living things have DNA; studying DNA helps us understand plants and animals; studying DNA helps us identify desirable traits like taste, nutritional value and productivity in crops
- Invite students to ask questions to clarify relationships about the role of DNA and genes in coding the instructions for characteristic traits passed from parents to offspring. Encourage students to think of What?, Why?, How? and Where? questions. Capture questions on the whiteboard or poster paper for review throughout the unit.

3. Preview the activity by sharing with students that they'll have a chance to build their own DNA structure and eat it too!
    - Just like our DNA, DNA in plants and animals contain what we refer to as the genetics of that organism. Each strand of DNA consists of four nitrogen bases: adenine (A), cytosine (C), thymine (T)and guanine (G). It does not matter if the DNA is from an animal, insect or a human, we all share the same four bases. In different organisms, the bases are just arranged to code for different proteins.[i]
    - Nitrogen bases follow a base pairing rule: adenine always pairs with thymine. Guanine always pairs with cytosine.
    - Gene is the root word of "genetics." Understanding genetics is the basis for understanding food production.
    - Genes make up an organism's "genotype." The genotype of an organism is expressed outwardly as the organism's "phenotype." The phenotype is typically what we see or notice.
4. Distribute student handout Delicious DNA. Pre-read the handout with the students. In this activity, students will create a DNA structure using a variety of food items and toothpicks. Students must be able to clearly describe the components of the DNA structure and create a logical legend using the candies provided.
    - Note: Students may elect to use food items for different components of the structure. Part of the learning process is giving students the opportunity to make logical connections and create their own roadmap of understanding.
5. Break students into collaborative working groups of two to three.
6. Clarify expectations: By the end of the class period, students should have assembled a 3D DNA model and completed the student handout.
7. Distribute lab supplies and one paper towel to each group. Monitor student progress and address questions.
8. After all students have completed the activity, prompt students to clean work areas.
9. Refer back to the boxes of information drawn on the whiteboard at the beginning of class. Ask students to re-evaluate this information, taking into consideration the knowledge they now have. Ask students what statements they would modify or add to the list. Share additional information as needed.
10. As a take-home challenge, ask students to think of a fruit or vegetable that can be found in different varieties (e.g., apples), and consider the role genetics plays in the traits we observe about that food item.

# Additional Content Support

## Pre/Post Assessment

This section provides a suggested assessment tool that may be used before and after a lesson to assess student readiness. See the Pre/Post Assessment file for a ready-to-distribute copy for your students.

1. What is DNA? Deoxyribonucleic acid
2. Where is DNA found? In the cell nucleus of eukaryotic cells and in the cytoplasm of prokaryotic cells
3. What does DNA look like? A double helix
4. What components make up DNA? Cytosine, Guanine, Adenine, Thymine, Sugar-phosphate backbone
5. Why is DNA important in trait inheritance? DNA carries the genetic information from parent to offspring from generation to generation

## Suggested Accommodations

This section provides optional tools to enrich learning and meet students where they are.

1. For students struggling to meet performance expectations:
    a. Unpacking students' prior knowledge during the questioning activity will be key to determine level of understanding about the DNA structure.
    b. If students do not know the primary components of the DNA structure, the suggested video goes over not only the history of the DNA structure discovery, but also the components of DNA and the critical use of modeling for this discovery. (See video from 10:40.)


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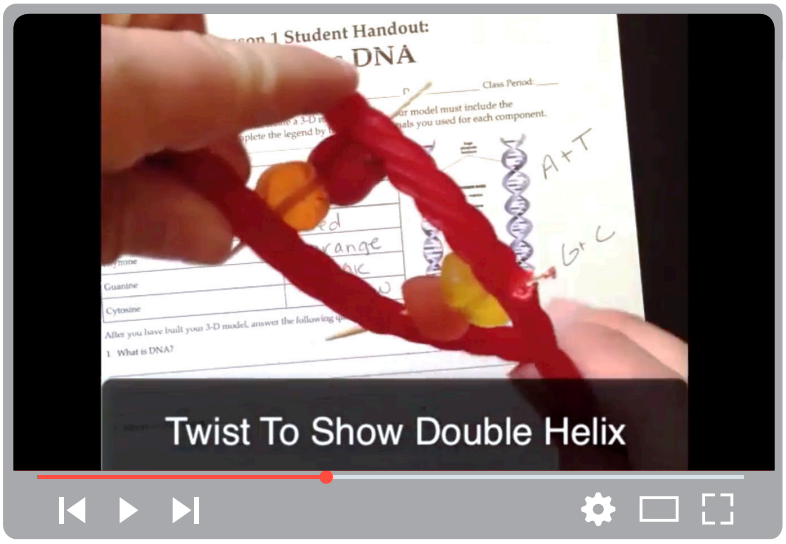
2. For students who have already met performance expectations and have high interest:
    a. History of the discovery of the double-helix structure is rich with scientists influencing other scientists in the race for the complete understanding of the DNA structure. To enhance the understanding of this discovery and how science builds upon asking questions, students may investigate the following questions.
        - How is the discovery of the double-helix structure of DNA an example on how one scientific hypothesis can influence another?
        - How did the base ratios play a role in the final model of the DNA structure?
        - How many scientists were involved and what were their contributions in the influence of the discovery of the double-helix structure?
        - What scientist(s) received the acknowledgment for the discovery of the structure of DNA? Do you think any other scientists should have received acknowledgment? Why or Why not?
3. For students who are English Language Learners, have special needs or are reading below grade level:
    a. Display the color image of DNA with a projector in order for students to see which base pairs match up.
4. For engaging ways to connect learning to students' home and community:
    a. Question students to see who has a dog. Have the students share some dog breeds with which they are familiar. As breeds are shared, ask the student to explain what they look like. Share that these characteristics are called traits and these traits are inherited from the animal's parents through DNA. This example will come back on another day. Ask students, "What is DNA?" and proceed with the DNA question activity.

## Rubrics

We have created two optional tools for evaluating learning at the end of each lesson.

- **LESSON RUBRIC:** This can be provided to students and used by the teacher for evaluation.
- **STUDENT REFLECTION:** This can be provided to students to empower them to self-assess learning before turning in the rubric and completed work. The general Student Reflection sheet can be found at the end of this educator guide.




**CHECK THIS LAB OUT ON YOUTUBE!**

https://youtu.be/f5bANXd10As

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**NAME:** _____ **DATE:** _____ **CLASS PERIOD:** _____

# DELICIOUS DNA

**DIRECTIONS:** Using the supplies provided, create a 3D model of DNA. Your model must include the components in the table below. Complete the legend by listing the materials you used for each component.

| LEGEND | |
|---|---|
| **DNA Component** | **Item We Used** |
| Sugar Phosphate Backbone | |
| Adenine | |
| Thymine | |
| Guanine | |
| Cytosine | |

**NITROGEN BASES:**

- Adenine
- Thymine
- Cytosine
- Guanine


**BASE PAIRING RULES:**

Adenine pairs with Thymine

Cytosine pairs with Guanine

After you have built your 3D model, answer the following questions.

1. What is DNA?

2. Where is DNA found?

3. Why is DNA important?

| GRADING RUBRIC – FOR TEACHER | | |
|---|---|---|
| Model includes all required components. Score _____/_____ | Model is assembled correctly and follows legend. Score _____/_____ | Questions are thoroughly completed on lab sheet. Score _____/_____ |



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**NAME:** _____ **DATE:** _____ **CLASS PERIOD:** _____

## Pre/Post Learning Assessment

1. What is DNA?

2. Where is DNA found?

3. What does DNA look like?

4. What components make up DNA?

5. Why is DNA important in trait inheritance?

Bringing Biotechnology to Life · Educator's Guide

LESSON HANDOUT 1

NAME: _____ DATE: _____ CLASS PERIOD: _____

Pre/Post Learning Assessment

1. What is DNA?

2. Where is DNA found?

3. What does DNA look like?

4. What components make up DNA?

5. Why is DNA important in trait inheritance?

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NAME: _____ DATE: _____ CLASS PERIOD: _____

# RUBRIC

| | | ADVANCED | PROFICIENT | NOVICE |
|---|---|---|---|---|
| DISCIPLINARY CORE IDEAS | Growth and Development of Organisms | Student can explain that organisms inherit traits from their parents and organisms change over time by genetic variations from parent to offspring during meiosis or the creation of sex cells. | Student can explain that organisms inherit traits from their parents and change over time by genetic variations. | Student can explain that organisms inherit traits from their parents. |
| | Inheritance of Traits | | | |
| | Variation of Traits | | | |
| PRACTICES | Asking Questions | Student can identify six or more questions that had to be asked while the structure of DNA was being researched. | Student can identify three to five questions that had to be asked while the structure of DNA was being researched. | Student can identify one to two questions that had to be asked while the structure of DNA was being researched. |
| CROSS-CUTTING CONCEPTS | Structure and Function | DNA double-helix model is complete with accurately paired nitrogen base pairings with the DNA components identified in the legend. All three questions on Student Handout are correctly answered with question three's answer mentioning inheritance of traits from parents. | DNA double-helix model is complete with accurately paired nitrogen base pairings with the DNA components identified in the legend. Two of the three questions on Student Handout are correctly answered. | DNA double-helix is incomplete or nitrogen base pairs are inaccurately paired. All three questions on Student Handout are answered incorrectly. |



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