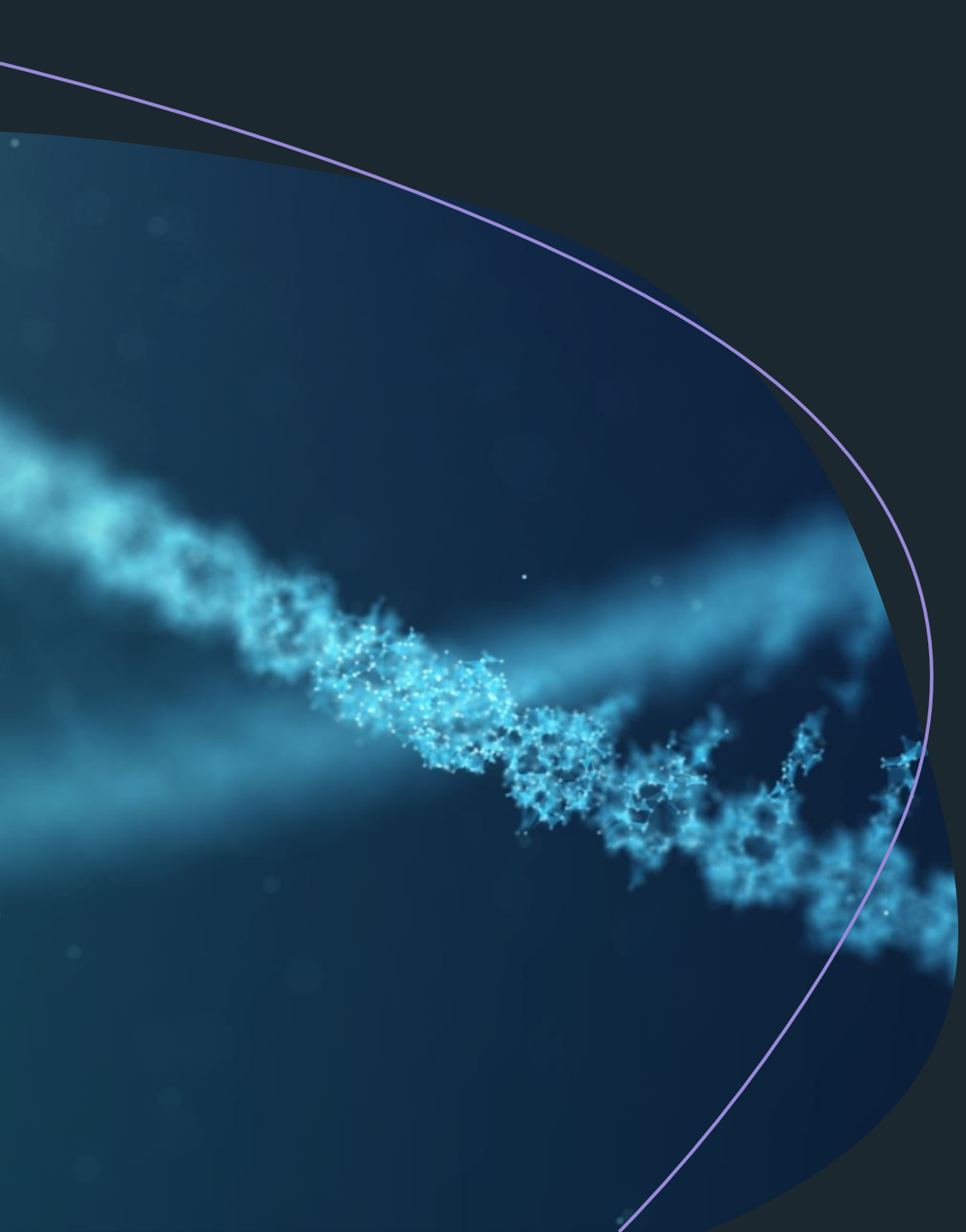


A Journey Through DNA

DNA DAY

Meet Gregory

- Gregory is a pea seed
- They are going to be your guide to learning about the incredible world of DNA and genetics!

Let's start from the beginning: What is DNA?

- DNA stands for **deoxyribonucleic acid**
- It is the instruction code for all living things and determines what you look like and everything that happens in your body.

What does DNA look like?

- DNA is known as a double helix–like a twisted ladder
- The rungs of this ladder are made of **Nucleotide Bases**: Adenine (A), Thymine (T), Guanine (G), and Cytosine (C)
- The order of these nucleotides is what makes each species and individual unique.
- A sequence of nucleotides is written out like this: ATCTTGCATGAGTCCCT

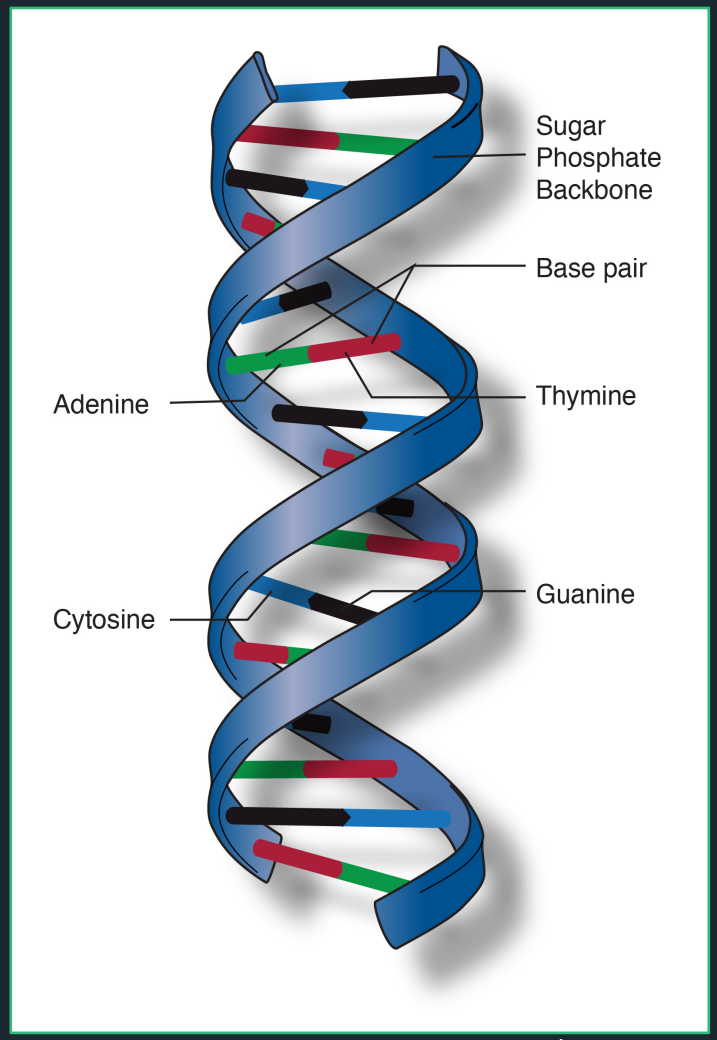


Image Credit: NHGRI

Where is DNA found?

- DNA is in the nucleus (the control center) of every cell.
- The DNA is wrapped in super tight coils so each cell contains about 6 feet (2 meters) of DNA!
- If you stretched out all the DNA from 1 person, it would stretch from the Earth to the Sun over 60 times!

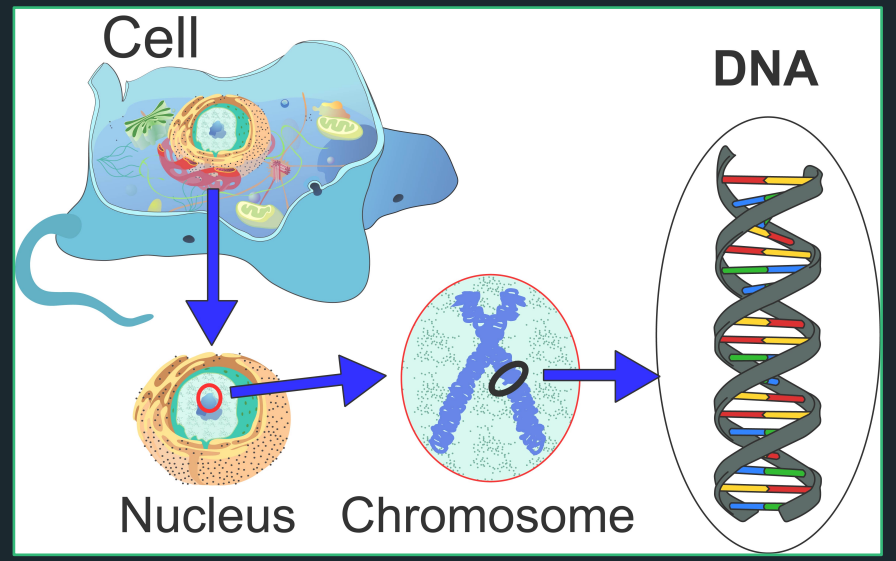


Image Credit: Pediaa

What has DNA?

- Everything living! From bacteria and butterflies to rose bushes and rhinos!
- Each species has a different amount of DNA and a different order of nucleotides
- All the DNA an individual has is called its **Genome**
- Scientists can compare genomes of different species or genomes of individuals in the same species to learn more about them.
- Some species have similar genomes, especially species that are a lot a like, such as mice and rats.
- Individuals within a species will have genomes that are nearly identical. Humans share about 99.9% of our genomes. All our differences are in only 0.1% of our DNA!

DNA Sequencing

- DNA can be collected from cells and run through a machine that reads the order of the nucleotides
- The entire genome sequence of an animal (including humans) can be determined in about a day's time
- Scientists have determined the sequence of millions of plants, animals, bacteria, and people.
- The Human Genome Project started in 1990 and was completed in 2003
- DNA has even been sequenced on the International Space Station!

Image Credit: Genomics England

Where does your DNA come from?

- DNA is organized into structures called **Chromosomes**
- Humans have 46 chromosomes–23 from their mother and 23 from their father.
- You get one copy of each chromosome from each parent.
- The process of receiving genetic information (chromosomes) from parents is known as **Inheritance**.

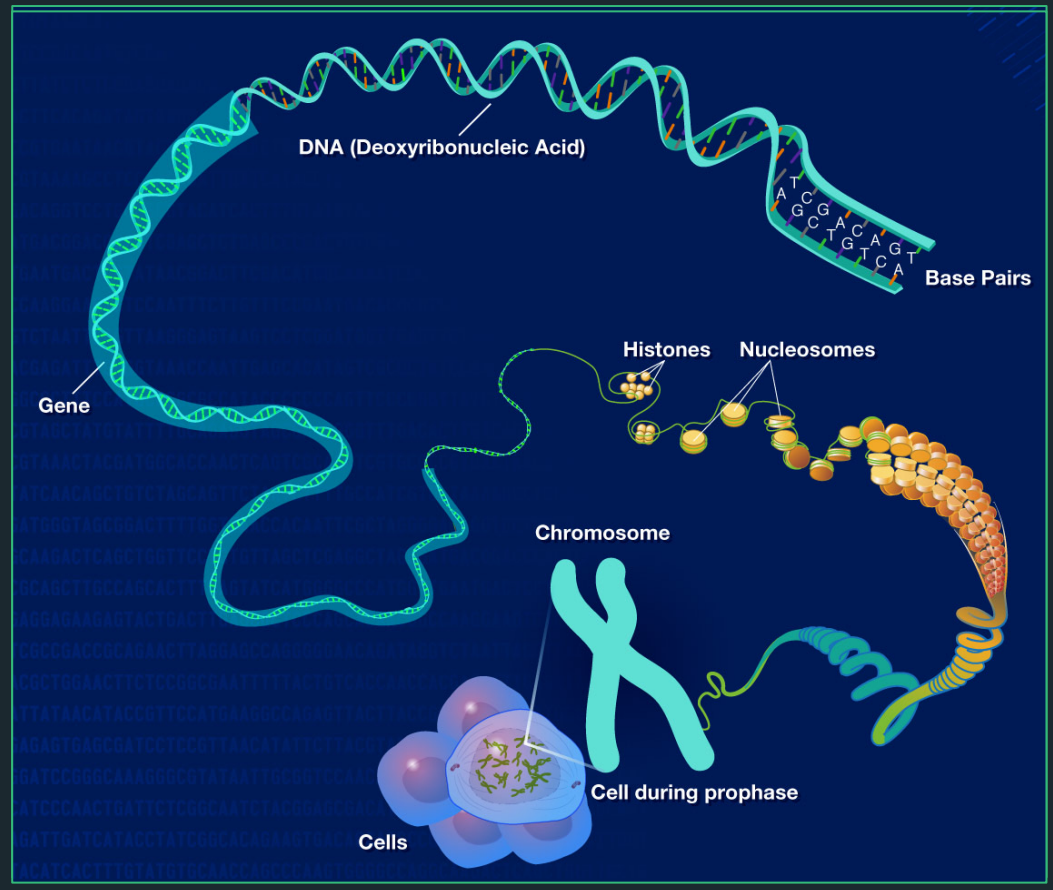


Image Credit: NHGRI

More about inheritance

- In the 1860s, an Austrian monk named Gregor Mendel began to learn how inheritance worked
- Mendel discovered the principles of inheritance by studying pea plants, long before anyone knew what DNA was!

What did we learn from Mendel?

- Mendel established three principles:
  - Offspring receive one copy of each gene from each parent
  - The inheritance of one trait is not connected to the inheritance of other traits
  - An organism will display the dominant gene
- While there are exceptions to these principles, these set the foundations of genetics study.

Some important terms

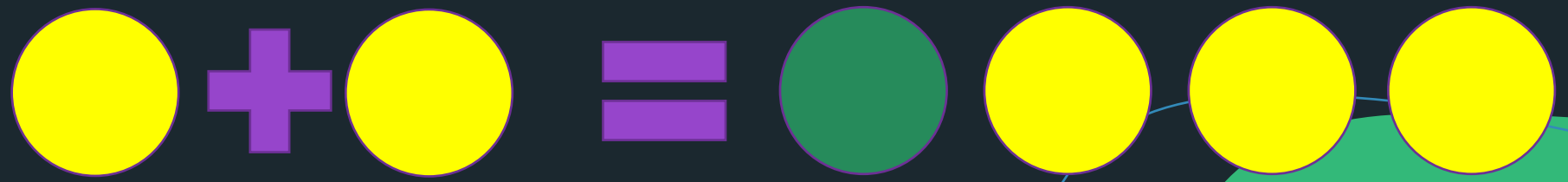
- Within the genome are specific areas of DNA called **Genes**.
- Genes provide the code for proteins, which are responsible for things like building muscles, enzymes, hormones and so much more in an organism. Genes can have more than one version.
- **Traits** are determined by genes. Different version of genes cause different versions of traits.
- We call these different versions of traits **Alleles**.
- Let’s go through an example on the next slide!

Mendel's Peas

- Mendel looked at the color of pea seeds, starting with either pure-bred Green or pure-bred Yellow.
  - Seed color is our trait
  - Green or yellow are the alleles
- When green seeded plants were crossed with yellow seeded plants, all the offspring had yellow seeds!

More Mendel's Peas

- When this new generation of yellow seeded plants were crossed together, 75% of the plants had yellow seeds and 25% had green seeds
  - Yellow is the **dominant** allele – when the allele for yellow is inherited, the seeds will be yellow
  - Green is **recessive** – only when two copies of the green allele are inherited will the seeds be green
- This means a trait can be 'hidden' or 'skip' generations before it is seen again
  - In humans, we often see this with the genes for red hair!

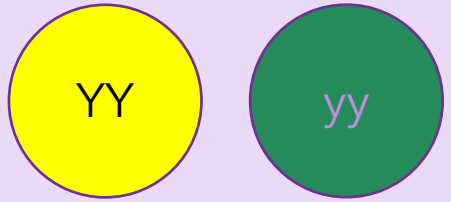


How do we study inheritance?

- To better understand inheritance, we need to look at genotype and phenotype
  - **Genotype**: The genetics of the trait
  - **Phenotype**: How the trait is expressed
- In the case of our peas, the phenotype is easy: yellow or green

Genotypes

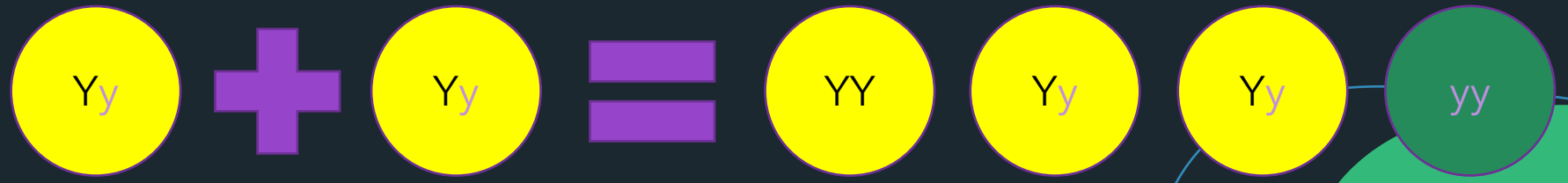
- Since we know the first generation were pure-bred plants and that yellow is the dominant trait, we can assign each seed a genotype
  - Dominate alleles are expressed as capital letters
  - Recessive alleles are expressed as lower-case letters



- This means each offspring's genotype is Yy, since they get one allele from each parent

Genotypes

- When that new Yy generation is crossed with each other, there are 3 possible genotypes:
  - YY
  - Yy (the same as yY, we always write the dominant allele first)
  - yy
- There is a 25% chance of the genotype being yy and the green phenotype showing up again!



Punnett Squares

- We can make a simple chart to look at possible genotypes and their frequency.
- These are called punnett squares.
- Let’s look at the one for our second generation of peas
  - The parent genotypes are written on the top and side
  - Their offspring's’ potential genotypes are then filled in

Parent genotype	Y	y
Y	YY	Yy
y	Yy	yy

Try it out!

Parent genotype	Y	y
y		
y		

- Use a punnett squre to determine the genotypic and phenotypic frequency of offspring of a Yy pea and a yy pea

How'd you do?

- In this generation, on average, half the peas would be yellow (Yy) and half would be green (yy).

Parent genotype	Y	y
y	Yy	yy
y	Yy	yy

How does this work in humans?

- Human genetics are a lot more complicated than pea plants, but we can still study how traits are passed through a family
- Most human genetics are done by sequencing the genome and looking at specific genes
- Different alleles have different DNA sequences that researchers and doctors can ‘read’ to understand genetic diseases
- Genetic counselors are important to helping people understand their genome sequences. This can be important not just to the person, who might be at risk of a disease, but also if someone could pass on a disease to their children.

Genomics

- The world of genetics and genomics is vast and constantly changing as we learn new things!
- Studying DNA helps us do all kinds of things: treat disease, solve crimes, protect wildlife, and so much more!
- Modern and future uses of genomics will make medicine more personalized and help us all live healthier lives.
- Hopefully this introduction to DNA makes you want to learn more!

Let's review

- DNA is double helix made of **nucleotide bases**.
- The order of the nucleotides is the organism's **genome.** This order can be found by using a DNA sequencing machine.
- DNA is organized into structures called **chromosomes**. Each organism has two copies of each chromosome: one inherited from each parent.
- In chromosomes are areas called **genes**. Genes code for a **trait** (e.g., pea seed color).
- A trait can have many variations, called **alleles** (e.g., yellow versus green).
- Alleles can be **dominant** or **recessive**. Recessive alleles require two copies (one from each parent) to be expressed.
- The genetics of a trail (e.g., Yy or yy) are called the **genotype** while the trait shown (e.g., yellow or green) is the **phenotype**.

Great work!

We hope you learned something new about DNA today (or at least had a good review).

Thank you for joining us for DNA Day and we hope you'll check out the other fun activities on our website!

National DNA DAY APRIL 25

Additional Resources

Websites

- National Human Genome Research Institute
- American Society of Human Genetics
- Genetic Science Learning Center