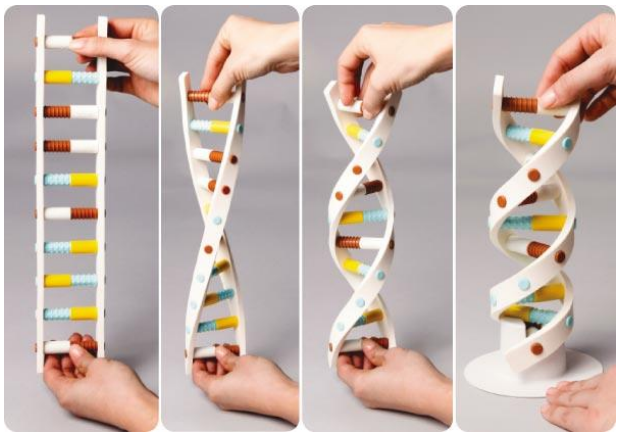
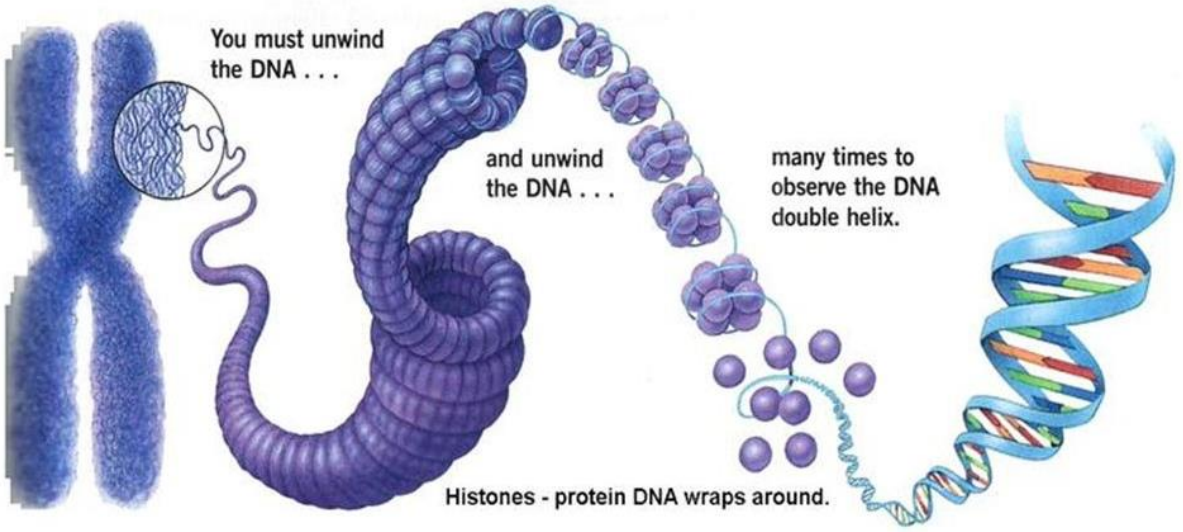
Understanding DNA

- DNA contains the recipe for creating an organism. That information is stored in long chains. If you were to unwind the DNA in a single human cell, it would be <u>6 feet</u> long.
  For <u>one</u> cell. Picture that for a second…



- To store all that information, DNA twists (and twists and twists) itself up into chromosomes.
- DNA untwists when it's time to read a sequence to make a protein
- Each section of DNA that codes for a specific protein is called a gene.



DNA uses only 4 nucleotides (building blocks) to create sequences that make you unique. →

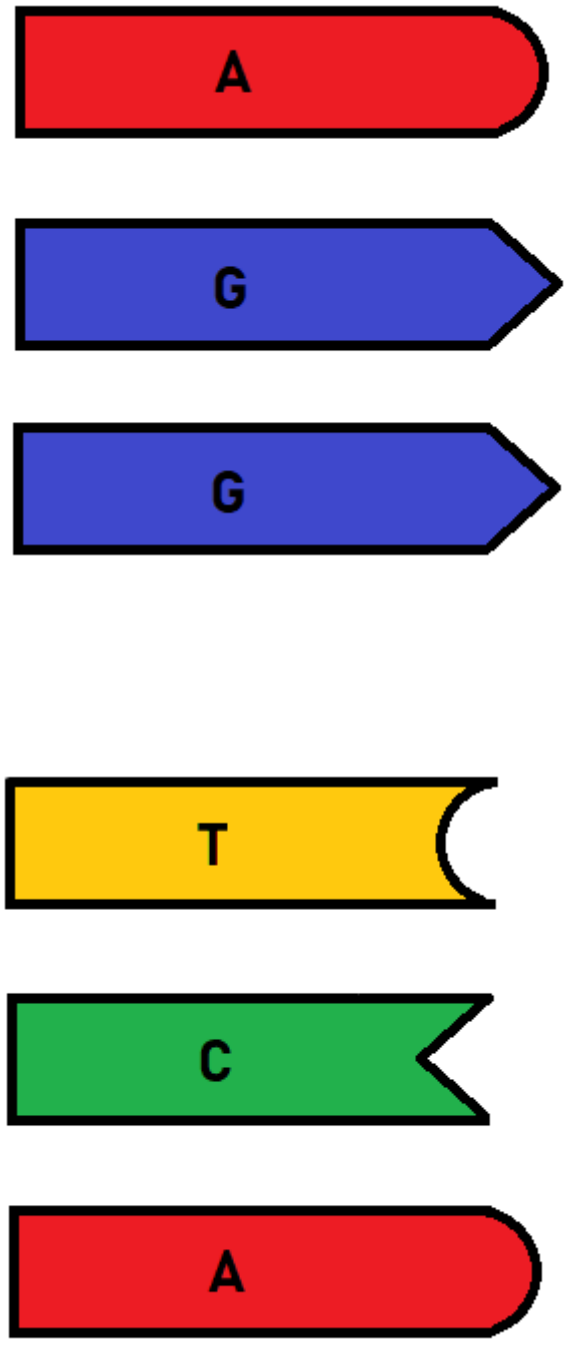
Nucleotides pair up predictably.

A – T or T - A
G - C or C - G

Figuring out the sequence of the human genome wasn't easy, and we still don't understand it perfectly. However, in 2003, international scientists from different disciples came together on the **Human Genome Project** and created a map of our DNA. Watch how:

How to Sequence The Human Genome by Mark Kiel – TED-Ed
https://www.youtube.com/watch?v=MvuYATh7Y74

Match up the following nucleotides with the right partner.



We can't yet read DNA like a book – that is, we don't understand every sequence, but we understand some of them and where to locate them on your chromosomes.

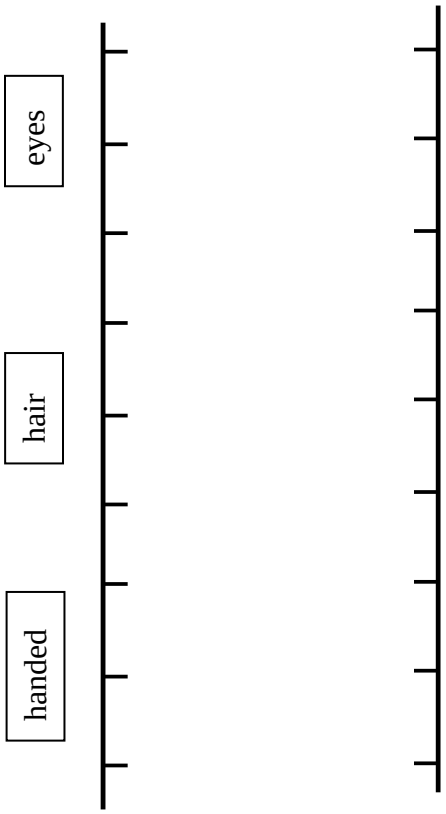
Using the chart on your left and your nucleotides, build a sequence of DNA for a person who has

1. blue eyes
2. blonde hair
3. right handed
4. medium height
5. pointy nose

Keep your sequences in order! (eyes, hair, handed, etc.)

Now, build yourself! Write the sequence (in pairs) below:

phenotype		genotype
Eyes:	blue	AGG
	green	AGC
	brown	TGG
	hazel	TGC
Hair:	brown	GCC
	black	GTG
	blonde	GCT
	red	GTC
Dominant hand:	right	TAA
	left	TTA
Height:	short	GAA
	medium	GGG
	tall	GTT
Nose shape:	round	ATA
	long	GTA
	pointy	CAT



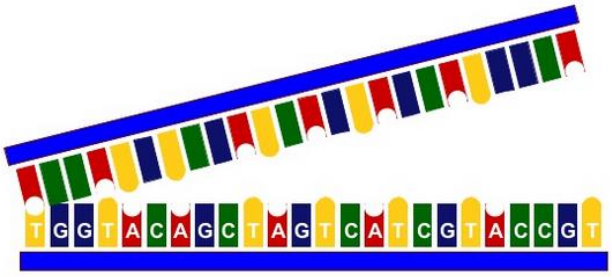
- Genetically, people are 99.9% identical. Asian or Caucasian, tall or short, 6-fingered, diabetic – you name it – all those differences account for .01% of your genome.
- You're a 98% DNA match with chimpanzees
- 92% the same as a mouse
- 18% the same as a dandelion

How is that possible? Think of all the mechanisms we share with other mammals (live birth, warm blooded, breathe oxygen…) and even with weeds (we have cells, we turn sugar into energy through the same chemical processes). The codes for those traits and processes are largely the same!

Reading the DNA recipe to make useful stuff

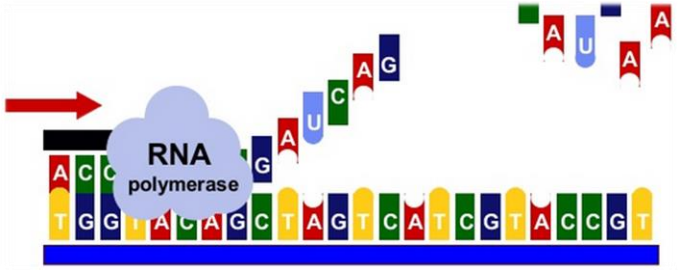
1. Your DNA forms a long chain until it's time to make a protein.

2. Then, it unzips.



Transcription

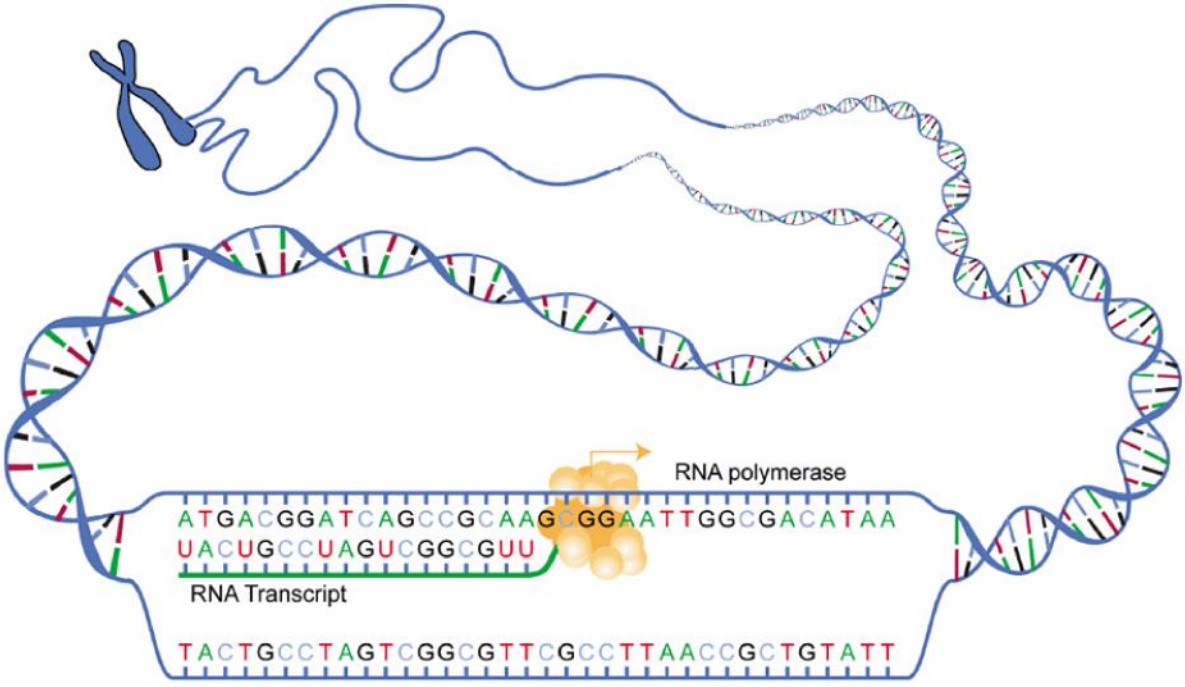
3. Your RNA moves up the chain reading the recipe and finding the matching nucleotide (U is temporarily subbed for T)



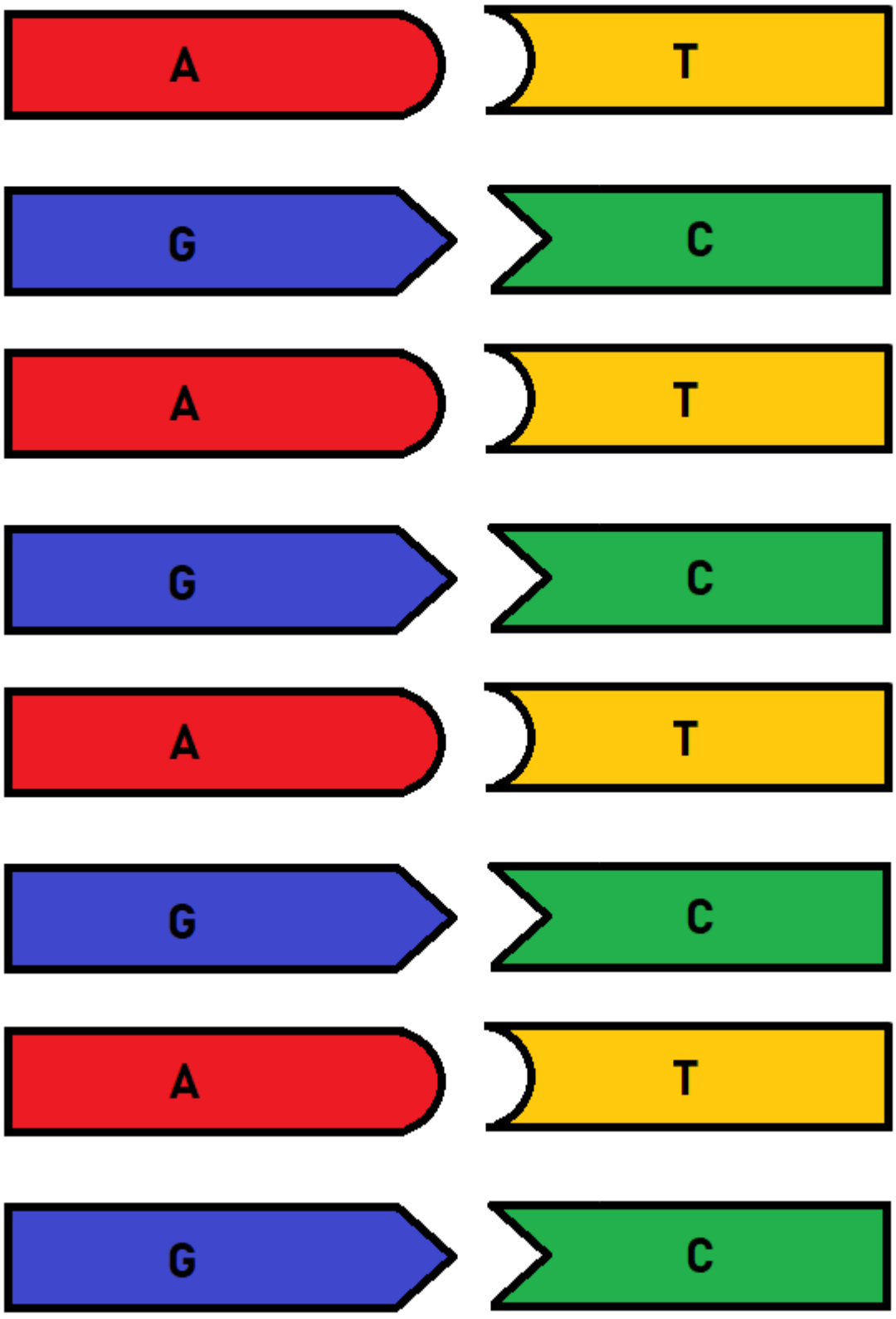
Translation

4. The messenger RNA floats off to deliver the recipe and build the protein. The DNA zips back up.

These 3-piece codons tell your cells what to build (thrombin, for example, helps your blood clot; hemoglobin carries O_2 in red blood cells.) In most living things, the code is the same. The code to make glutamine (CAG) is the same in you as it is in a racoon.



Print and cut out nucleotides to use in activities.



Mutations and DNA

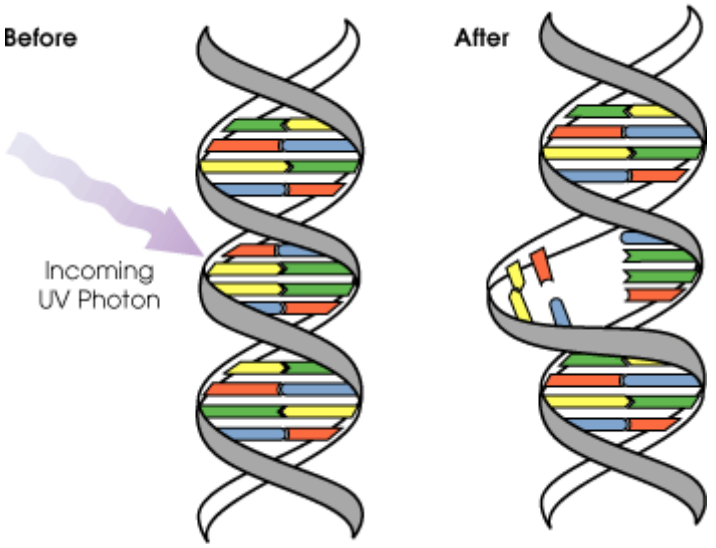
- Mutation = change
- Mutations can affect a single nucleotide or a group of them

Causes of Mutations

1) Mutations can be passed to from parents to offspring.
2) Mutations can occur during your lifetime as a copying error when a cell divides or when cells are damaged.

Outside forces that can mutate your genes include

- UV rays from the sun (sunburn)
- Radioactive ooze
- Chemicals like benzopyrene (found in cigarettes) and vinyl chloride (found in some plastics)
- Viruses (Hep B and HIV)



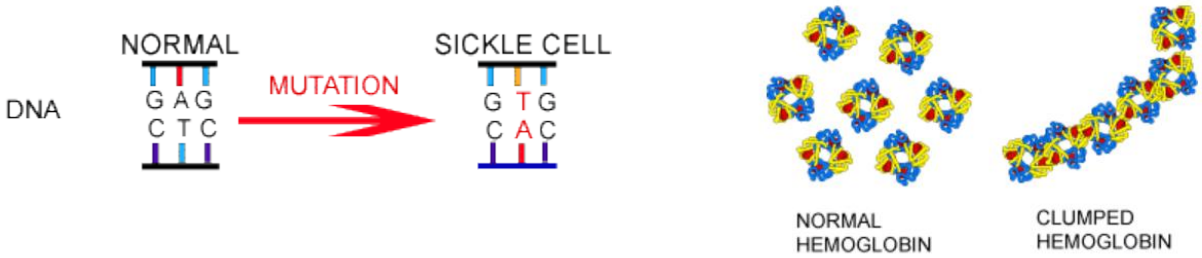
UV light affects DNA where two thymine (T) nucleotides appear next to each other. UVB light breaks their horizontal bonds and causes them to stick to each other. Your body repairs much of this damage, but over time errors build up. Too many errors can cause cell death or cancer.

Consequences of Mutations

Most mutations are harmless. Some will kill you. Everyone once in a while, a mutation is very helpful.

If a mutation occurs in a non-coding region of your DNA (a section the cell isn't using), it's fine. Remember, you have 6 feet of DNA in every cell, only a small portion of that information is actively being accessed to make proteins. It's like have a 4000 page recipe book with all the recipes in the world, but you're a pastry chef. If there's a problem with the section on grilling meat, it doesn't affect you very much. Most mutations are of this type.

When mutations happen to the recipes your cells need to function, it can cause cells to create incorrect proteins. In sickle cell anemia, a mutated nucleotide sequence causes cells to produce a hemoglobin protein that clumps, doesn't carry oxygen in the blood, and causes red blood cells to change shape.



Sickle cell anemia is recessive. Circle all genotypes that have it:

Ss SS ss

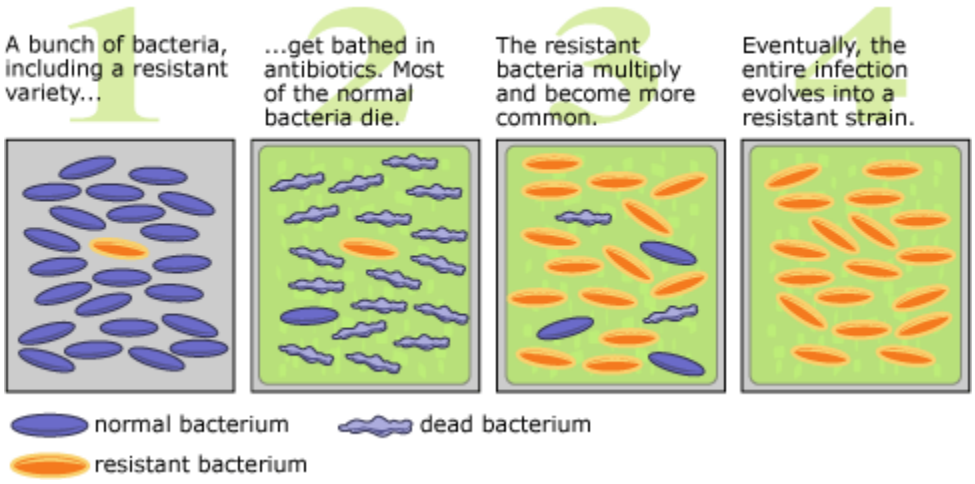
This mutation is both good a bad. If you have it, it's bad news. However, **carriers** of the mutation (Ss) get a benefit. Turns out they're resistant to malaria (a deadly tropical disease). The parasites that cause malaria cannot grow in their cells.

Why might the mutation for sickle anemia still be around today? Why didn't everyone with the mutation die off a long time ago?

_____

_____

If a mutation helps an organism survive, it's quick to catch on. Consider what happens when a random mutation makes bacteria better at surviving antibiotics.



One Common Ancestor Behind Blue Eyes

Jeanna Bryner, Live Science Managing Editor | January 31, 2008 03:34am ET

People with blue eyes have a single, common ancestor, according to new research.

A team of scientists has tracked down a genetic mutation that leads to blue eyes. The mutation occurred between 6,000 and 10,000 years ago. Before then, there were no blue eyes.

"Originally, we all had brown eyes," said Hans Eiberg from the Department of Cellular and Molecular Medicine at the University of Copenhagen.

The mutation affected the so-called OCA2 gene, which is involved in the production of melanin, the pigment that gives color to our hair, eyes and skin.

"A genetic mutation affecting the OCA2 gene in our chromosomes resulted in the creation of a 'switch,' which literally 'turned off' the ability to produce brown eyes," Eiberg said.

The genetic switch is located in the gene adjacent to OCA2 and rather than completely turning off the gene, the switch limits its action, which reduces the production of melanin in the iris. In effect, the turned-down switch diluted brown eyes to blue.

If the OCA2 gene had been completely shut down, our hair, eyes and skin would be melanin-less, a condition known as albinism.

"It's exactly what I sort of expected to see from what we know about selection around this area," said John Hawks of the University of Wisconsin-Madison, referring to the study results regarding the OCA2 gene. Hawks was not involved in the current study.

Baby blues

Eiberg and his team examined DNA from mitochondria, the cells' energy-making structures, of blue-eyed individuals in countries including Jordan, Denmark and Turkey. This genetic material comes from females, so it can trace maternal lineages.

They specifically looked at sequences of DNA on the OCA2 gene and the genetic mutation associated with turning down melanin production.

Over the course of several generations, segments of ancestral DNA get shuffled so that individuals have varying sequences. Some of these segments, however, that haven't been reshuffled are called haplotypes. If a group of individuals shares long haplotypes, that means the sequence arose relatively recently in our human ancestors. The DNA sequence didn't have enough time to get mixed up.

"What they were able to show is that the people who have blue eyes in Denmark, as far as Jordan, these people all have this same haplotype, they all have exactly the same gene changes that are all linked to this one mutation that makes eyes blue," Hawks said in a telephone interview.

Melanin switch

The mutation is what regulates the OCA2 switch for melanin production. And depending on the amount of melanin in the iris, a person can end up with eye color ranging from brown to green. Brown-eyed individuals have considerable individual variation in the area of their DNA that controls melanin production. But they found that blue-eyed individuals only have a small degree of variation in the amount of melanin in their eyes.

"Out of 800 persons we have only found one person which didn't fit — but his eye color was blue with a single brown spot," Eiberg told *LiveScience*, referring to the finding that blue-eyed individuals all had the same sequence of DNA linked with melanin production.

"From this we can conclude that all blue-eyed individuals are linked to the same ancestor," Eiberg said. "They have all inherited the same switch at exactly the same spot in their DNA."

Eiberg and his colleagues detailed their study in

the Jan. 3 online edition of the journal *Human Genetics*.

That genetic switch somehow spread throughout Europe and now other parts of the world.

"The question really is, 'Why did we go from having nobody on Earth with blue eyes 10,000 years ago to having 20 or 40 percent of Europeans having blue eyes now?" Hawks said. "This gene does something good for people. It makes them have more kids."

Sources:
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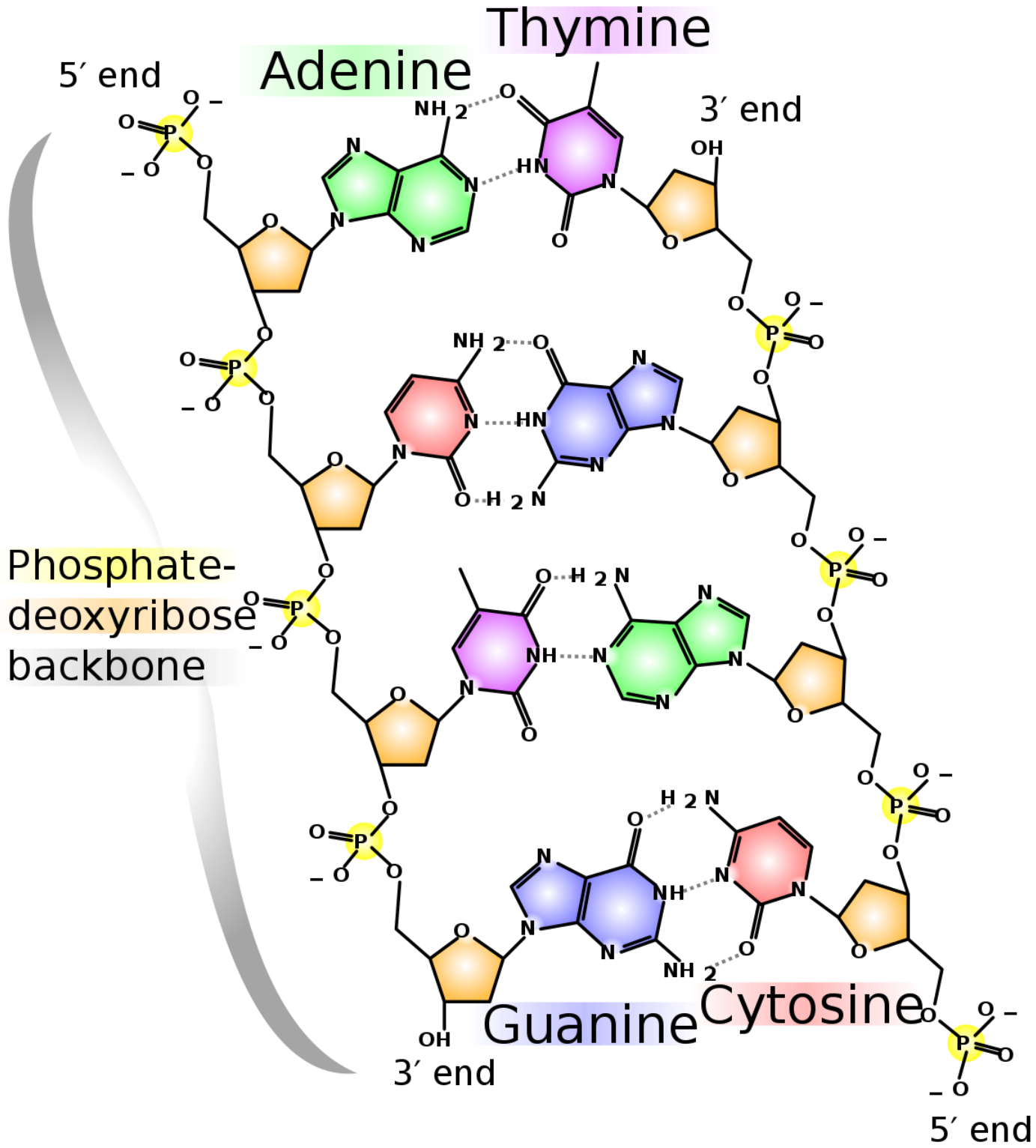
Thymine
Adenine
5′ end
3′ end
Phosphate-
deoxyribose
backbone
Guanine
Cytosine
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