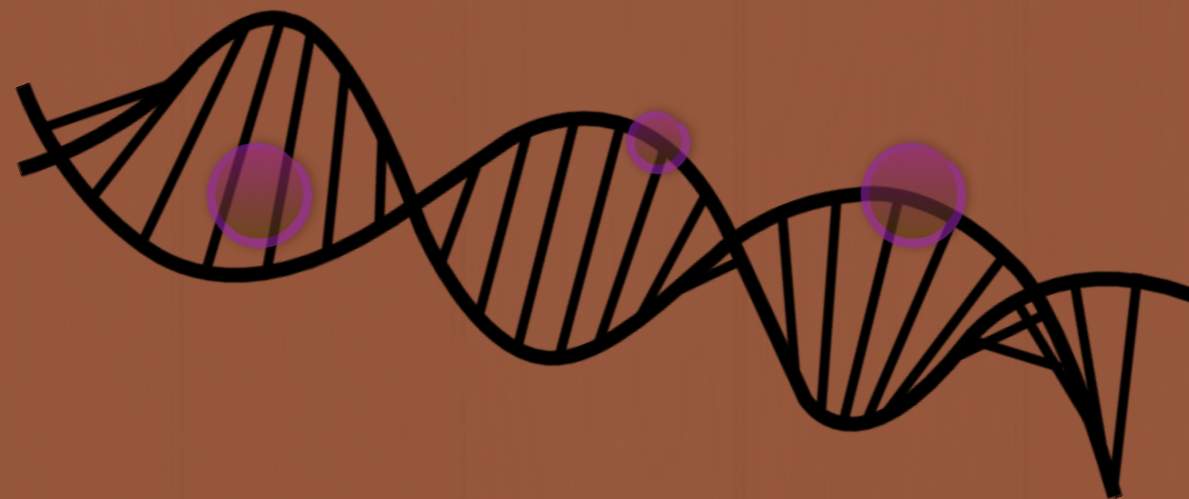


Nature
vs.
Nurture:
Epigenetics



Until recently, all our characteristics were thought to be shaped by two different factors

1 Nature

The genetic information that we inherit from our mother and father



2 Nurture

The influence of our environment



Epigenetics suggests a combination of these

Epigenetics

This is a new branch of genetics that is shedding light on the “nature vs. nurture” debate.

“Epi” means “above” or “on top of” so epigenetics refers to modifications that occur on top of your genes. Environmental factors actually cause your cells and genetic code to change over your lifetime. Your genetic code itself is always the same, but genes can be “turned on” or “turned off.”

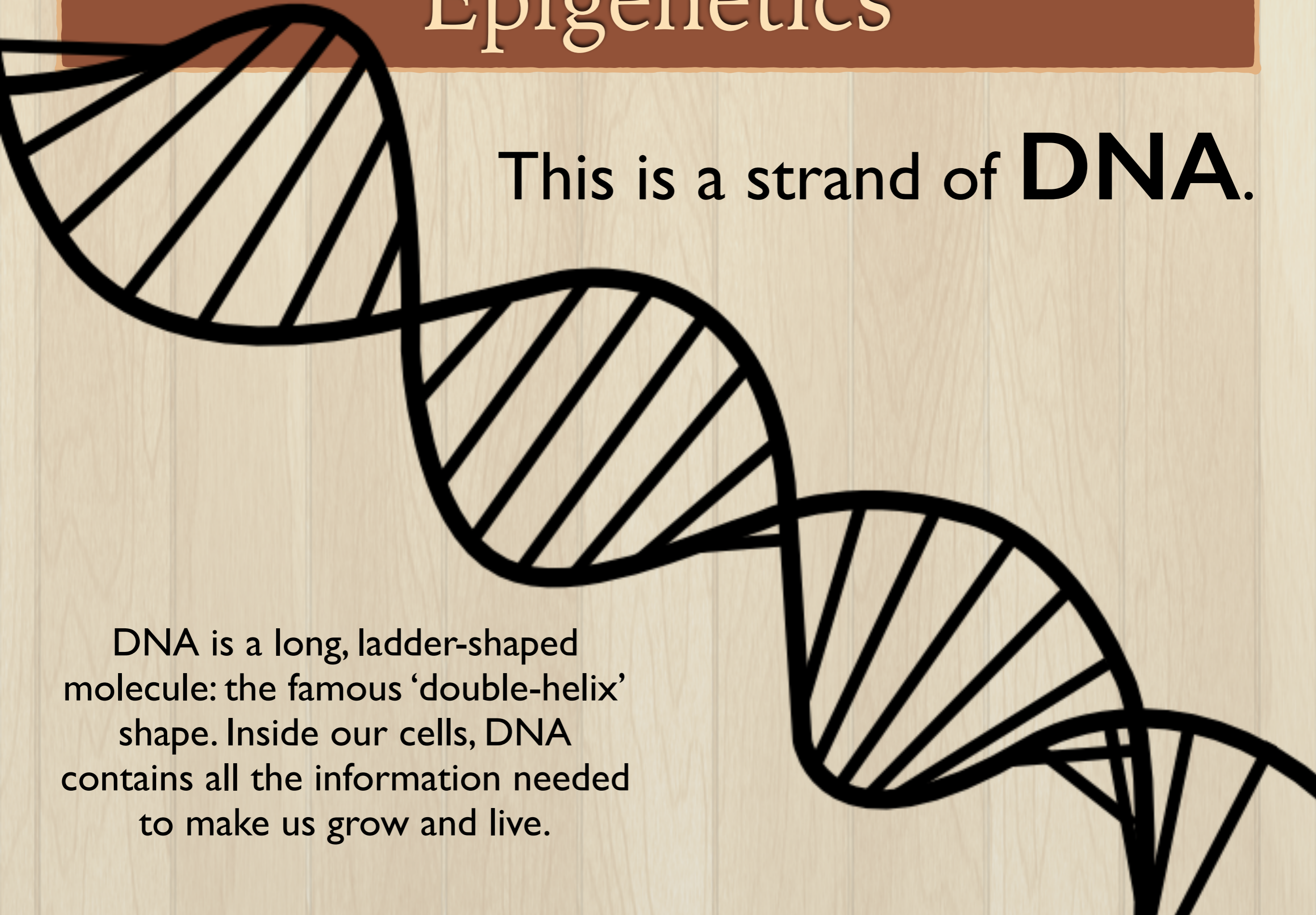


For example, your diet can cause “epigenetic changes” to your DNA.

Epigenetics

This is a strand of **DNA**.

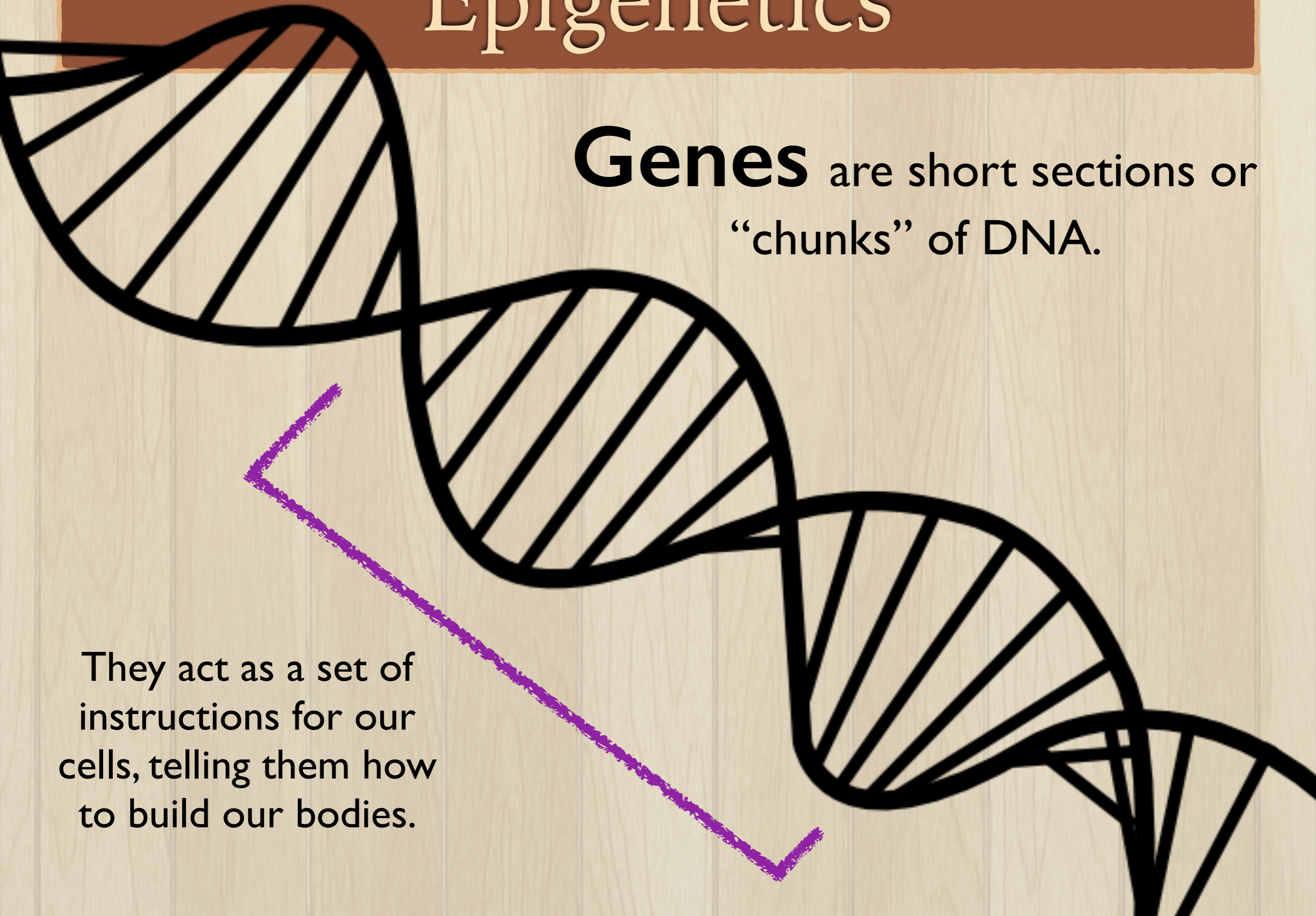
DNA is a long, ladder-shaped molecule: the famous 'double-helix' shape. Inside our cells, DNA contains all the information needed to make us grow and live.



Epigenetics

Genes are short sections or “chunks” of DNA.

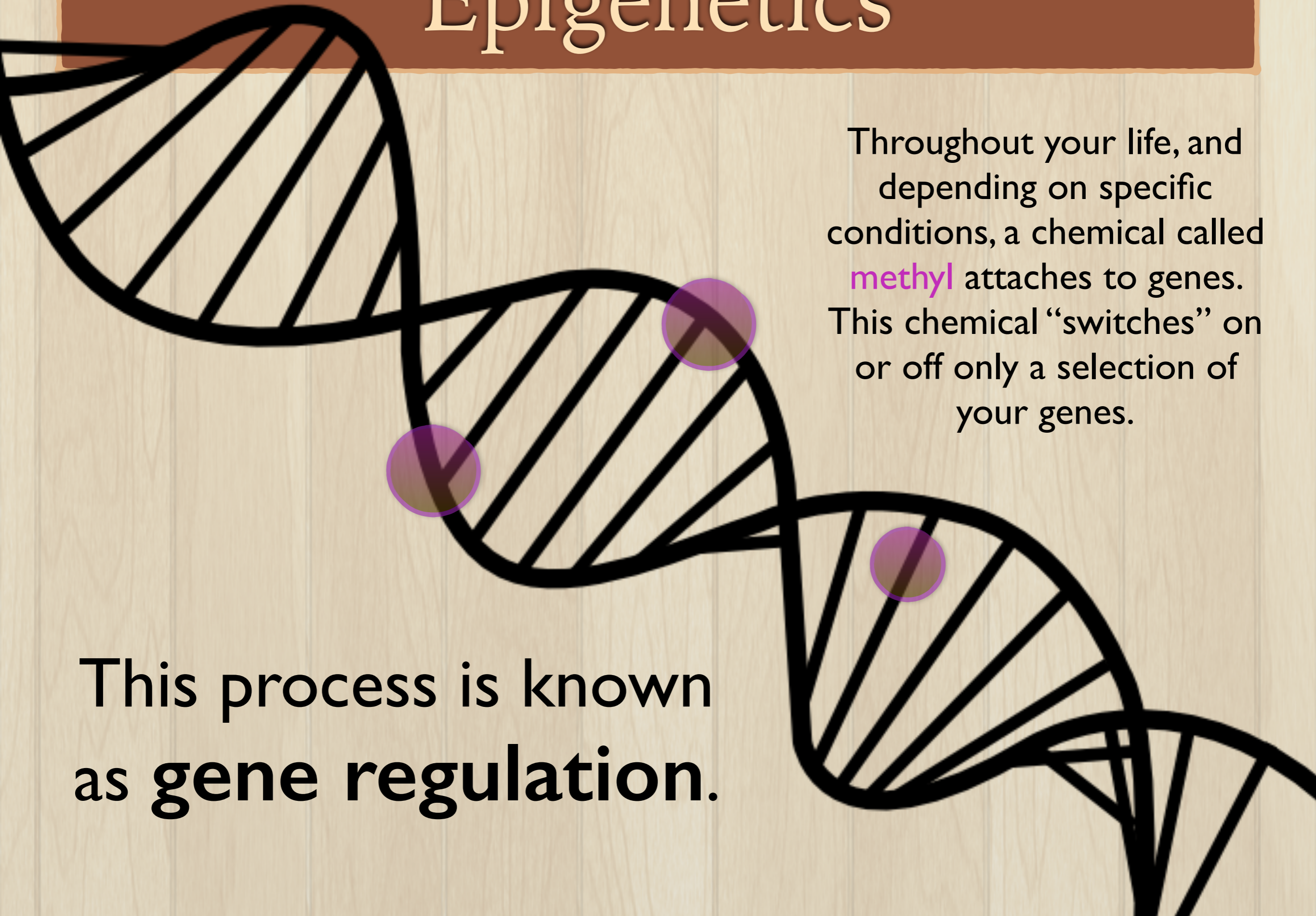
They act as a set of instructions for our cells, telling them how to build our bodies.



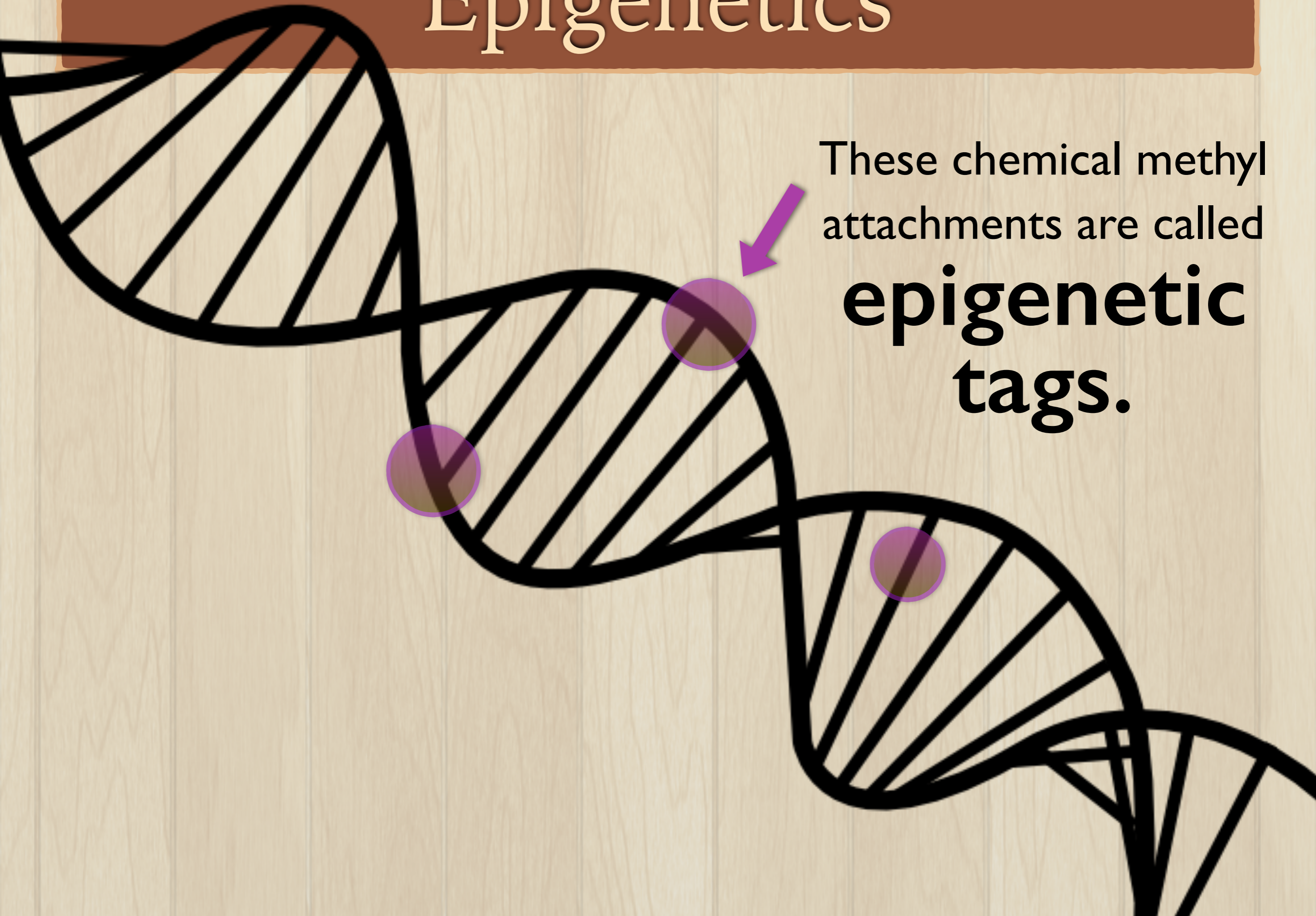
Epigenetics

Throughout your life, and depending on specific conditions, a chemical called **methyl** attaches to genes. This chemical “switches” on or off only a selection of your genes.

This process is known as **gene regulation**.

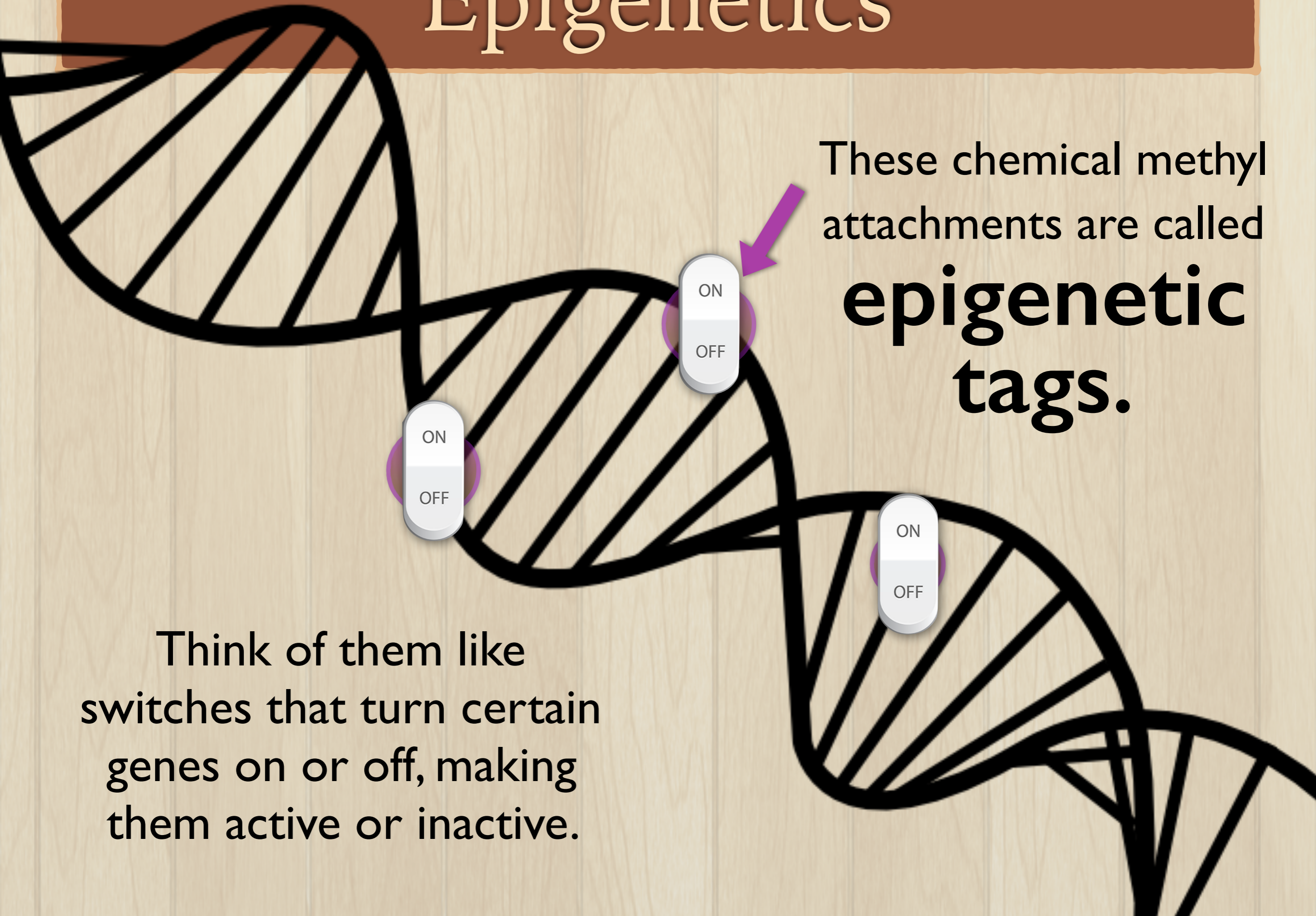


Epigenetics



These chemical methyl attachments are called **epigenetic tags.**

Epigenetics



These chemical methyl attachments are called **epigenetic tags.**

Think of them like switches that turn certain genes on or off, making them active or inactive.

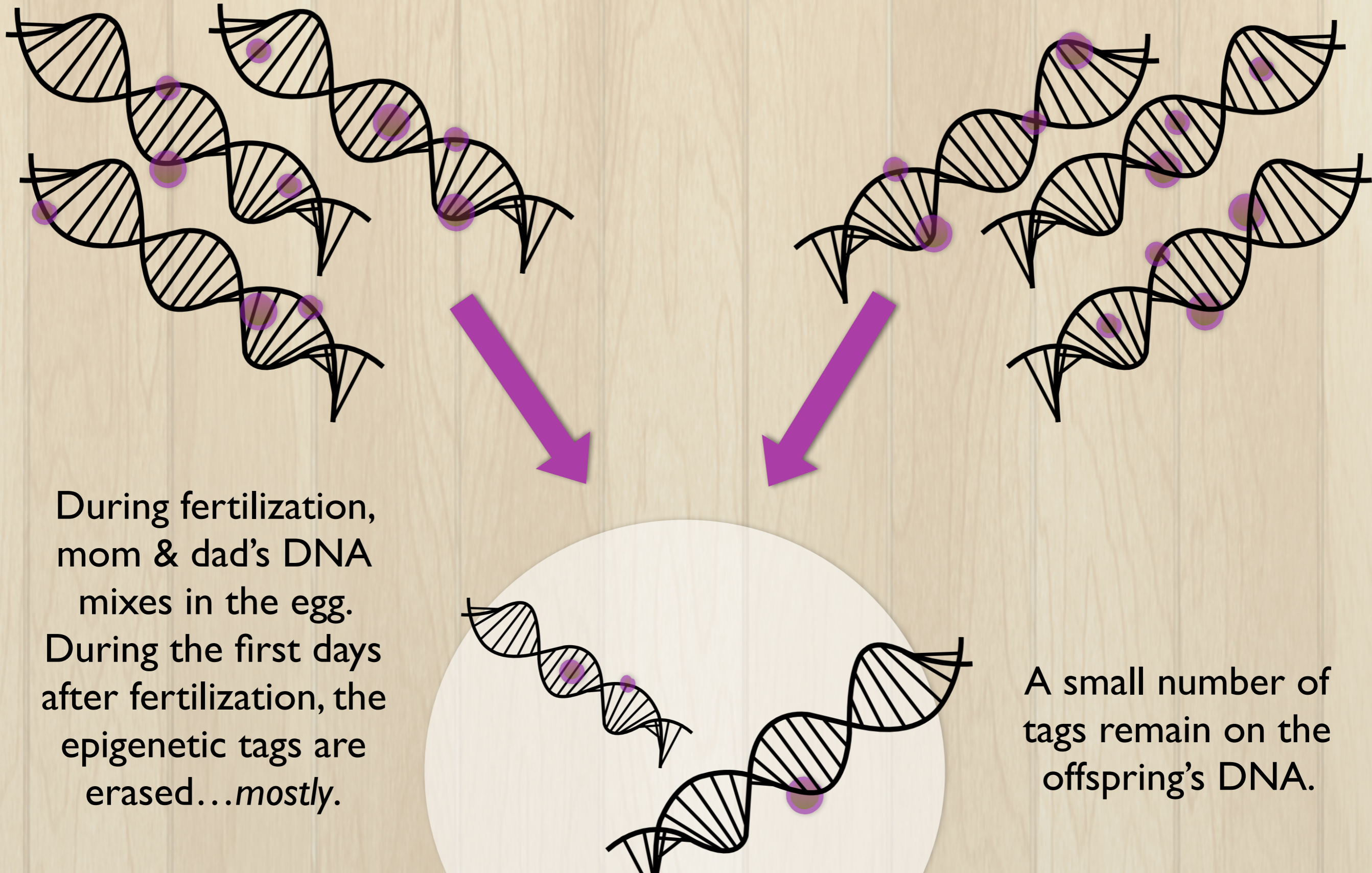
Epigenetics



Your **lifestyle**
determines which
genes get “switched
on” or “switched off.”

What (and how much) you eat, how much you exercise, if you smoke, if you get a disease, if you experience high stress, if you are exposed to chemicals, etc...can all impact the way your genes are expressed.

Epigenetics



During fertilization, mom & dad's DNA mixes in the egg. During the first days after fertilization, the epigenetic tags are erased...*mostly*.

A small number of tags remain on the offspring's DNA.

Epigenetics

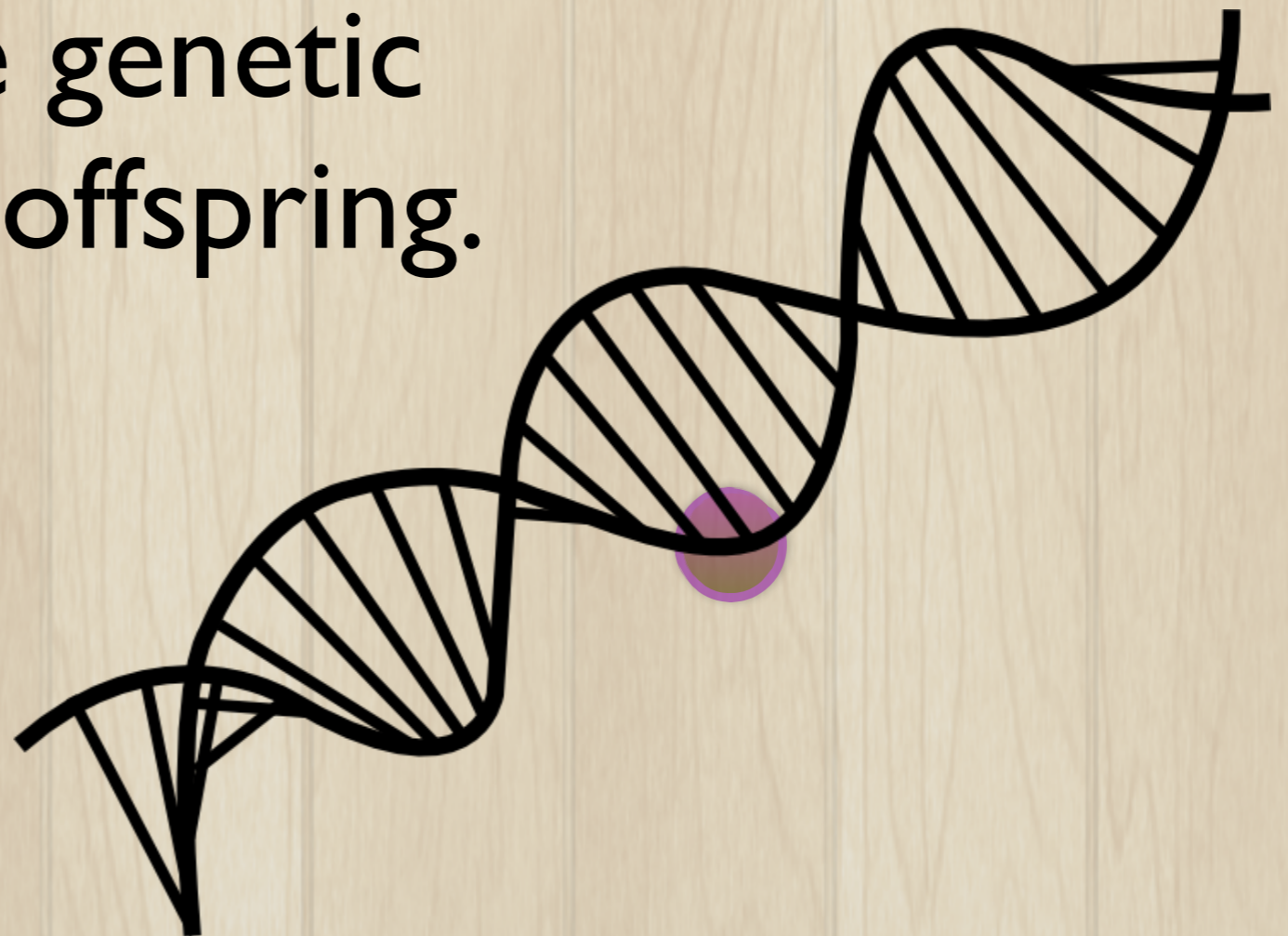
Because a small number
of tags remain on the
offspring's DNA...

...these are called
**“imprinted
genes.”**



Epigenetics

Thus, the environment and lifestyle choices of the parents actually modified the genetic code of their offspring.



Inherited Stress Tolerance?

Some people naturally respond well to stress. When there is too much work to get done, these people remain calm, organize time well, finish the work with focus and without feeling overwhelmed.



Other people do not respond well to stress. When they have too much work to do, they feel like the world is crushing them. They feel panic. Sometimes, they feel so much panic that they can't focus on the work that needs to be done.



Inherited Stress Tolerance?

The lucky ones have a stress response gene turned on.



The unlucky ones have the stress response gene turned off.



Stress Gene Experiment



Experimental Group 1:
Baby rats are nurtured
by a mother rat



Experimental Group 2:
Baby rats are *neglected*
by a mother rat

Stress Gene Experiment



Group 1:

The babies' DNA is tested and epigenetic tags are visible on the stress response gene, turning it "on." These rats respond very well in stressful situations for the rest of their lives.



Group 2:

The babies' DNA is tested and epigenetic tags are NOT present on the stress response gene, keeping it "off." These rats do NOT respond well in stressful situations for the rest of their lives.

Stress Gene Experiment



Group 1:

The offspring of these rats **ALSO** have epigenetic tags on the stress response gene: the babies inherit an imprinted gene on which the stress response gene is “turned on.”



Group 2:

The offspring of these rats **ALSO** have **NO** epigenetic tags on the stress response gene. Thus, these babies do not respond well to stress because their **PARENTS** were not nurtured by a mother rat.

Inherited Stress Tolerance?

The rats that were *not* nurtured as babies had the stress response gene “turned off.” In this case, the rats could not handle stressful situations well for the rest of their lives. They also passed this inability to respond to stress to their children.



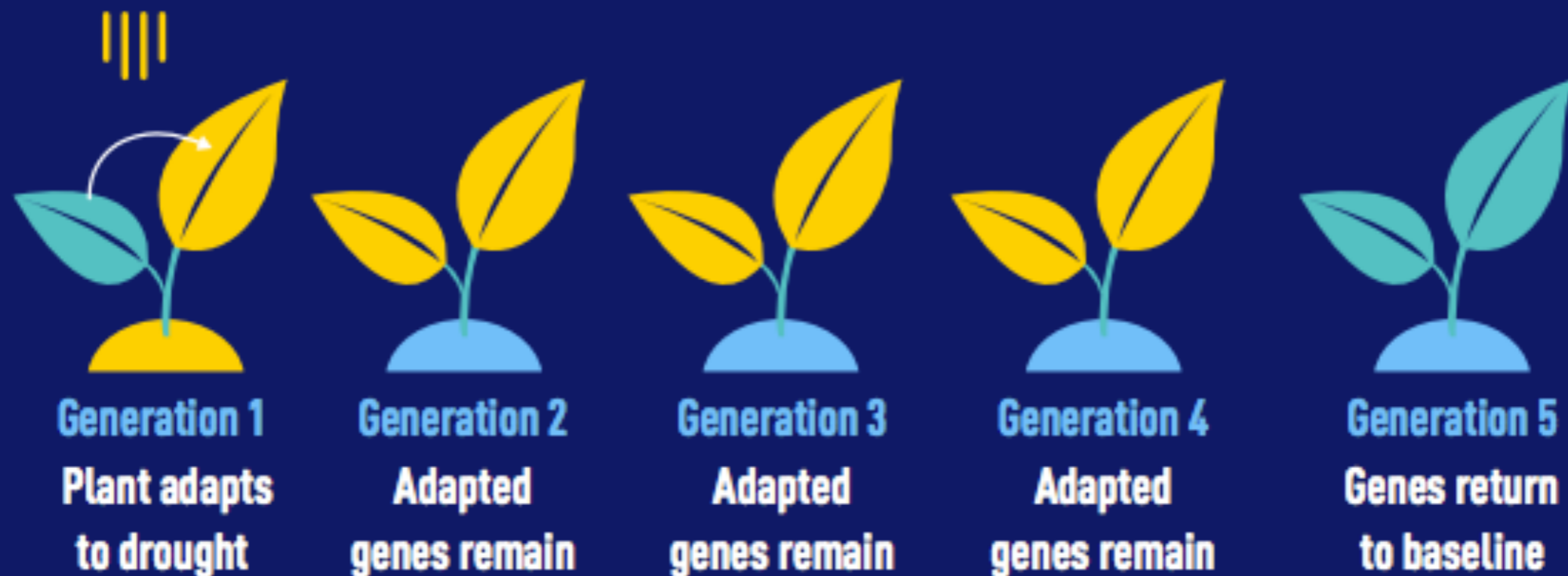
This study shows that attentive, loving parents set their children (and grandchildren!) up for future success by creating an epigenetic modification that allows the children to better cope with stress. **The environment can change our genes, and our genes impact certain aspects of our behavior.**

Are Epigenetic Changes Permanent?

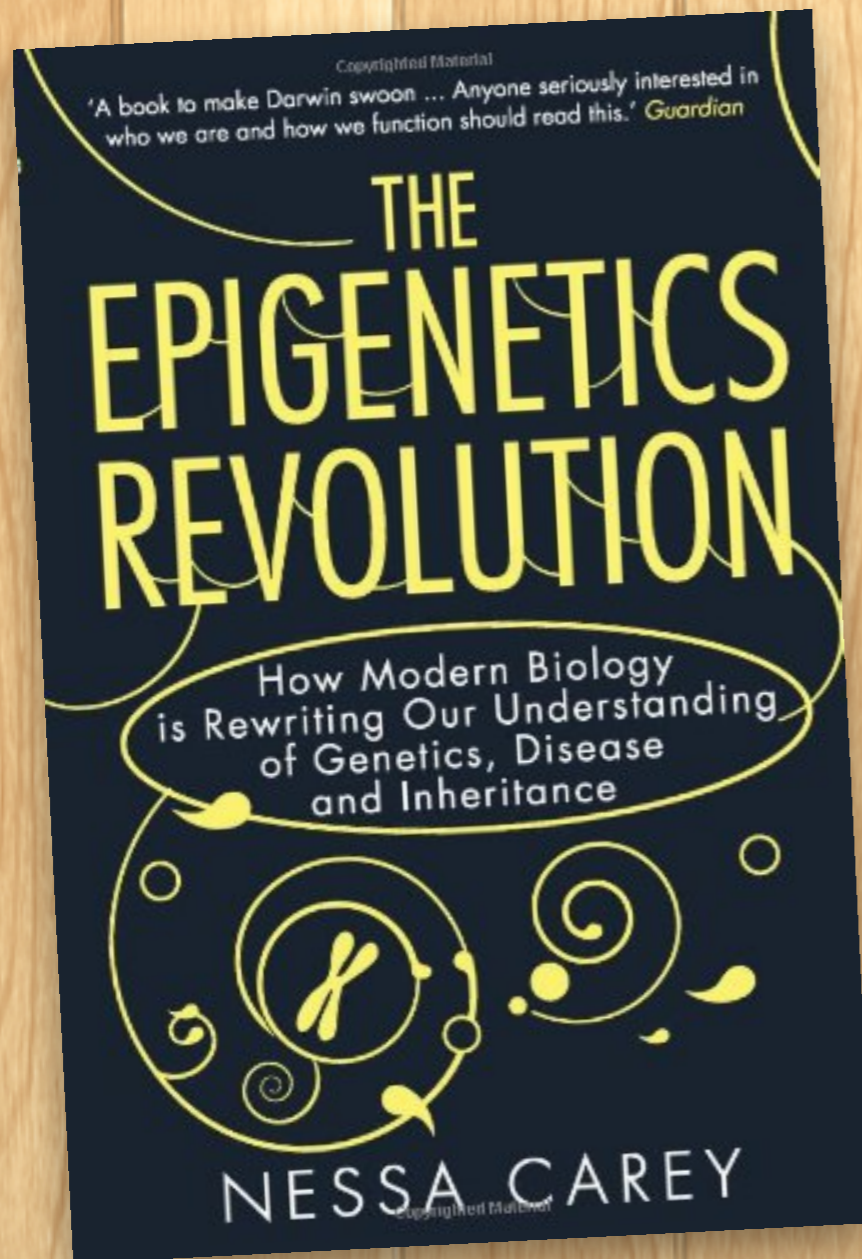
Although epigenetic changes may be passed from one generation to another, we know they are dynamic and reversible. This is commonly observed in nature, even in plants.

During droughts, some plants adapt to survive and then pass those adapted genes to the next generation

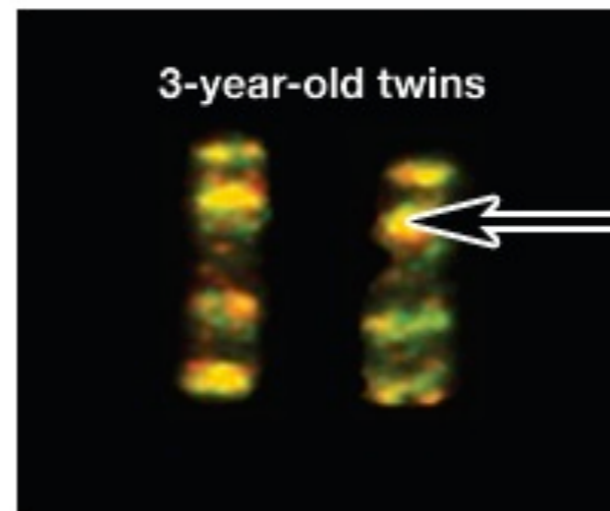
If the next two or three generations don't experience another drought, the epigenetic changes are usually no longer passed on.



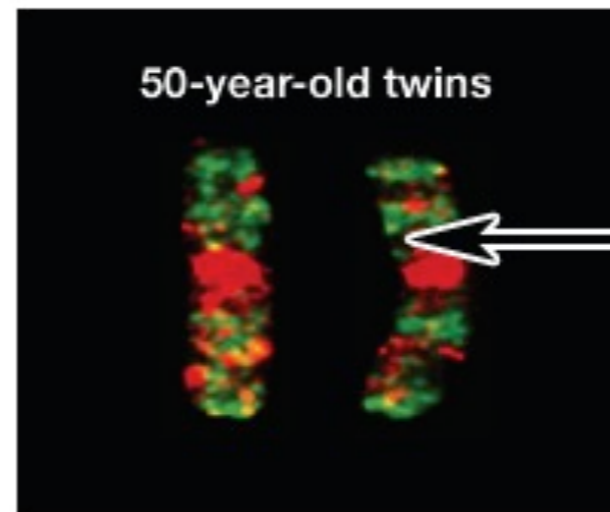
Epigenetics



Chromosome 3 Pairs
3-year old twins vs. 50-year-old twins



Yellow shows where the twins have epigenetic tags in the same place.



Red and green show where the twins have epigenetic tags in different places.

The DNA of twins begins the same, but over the course of their lives, different health choices and environmental stimuli cause the DNA code to change.

Epigenetics



Q: What does this mean for the nature vs. nurture debate?

A: That we are not defined by our genes. Our lifestyle choices can actually impact our genetic codes, causing certain genetic traits to express themselves more or less strongly.

But, this does not mean that our genes don't impact who we are. Some genes are not modifiable, meaning that epigenetic tags do not affect those genes.

The nature vs. nurture debate rages on as psychologists try to understand which plays a *larger part* in our development. They also try to discover which plays a larger part in specific behaviors - like gender expression, athletic ability, or optimism.

