

You Are What Your Mother Ate: The Science of Epigenetics



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Today's Lecture



Daniel Lieber

- What is epigenetics?



Kerry Samerotte

- Epigenetics and us



Brian Beliveau

- Past, present, and future

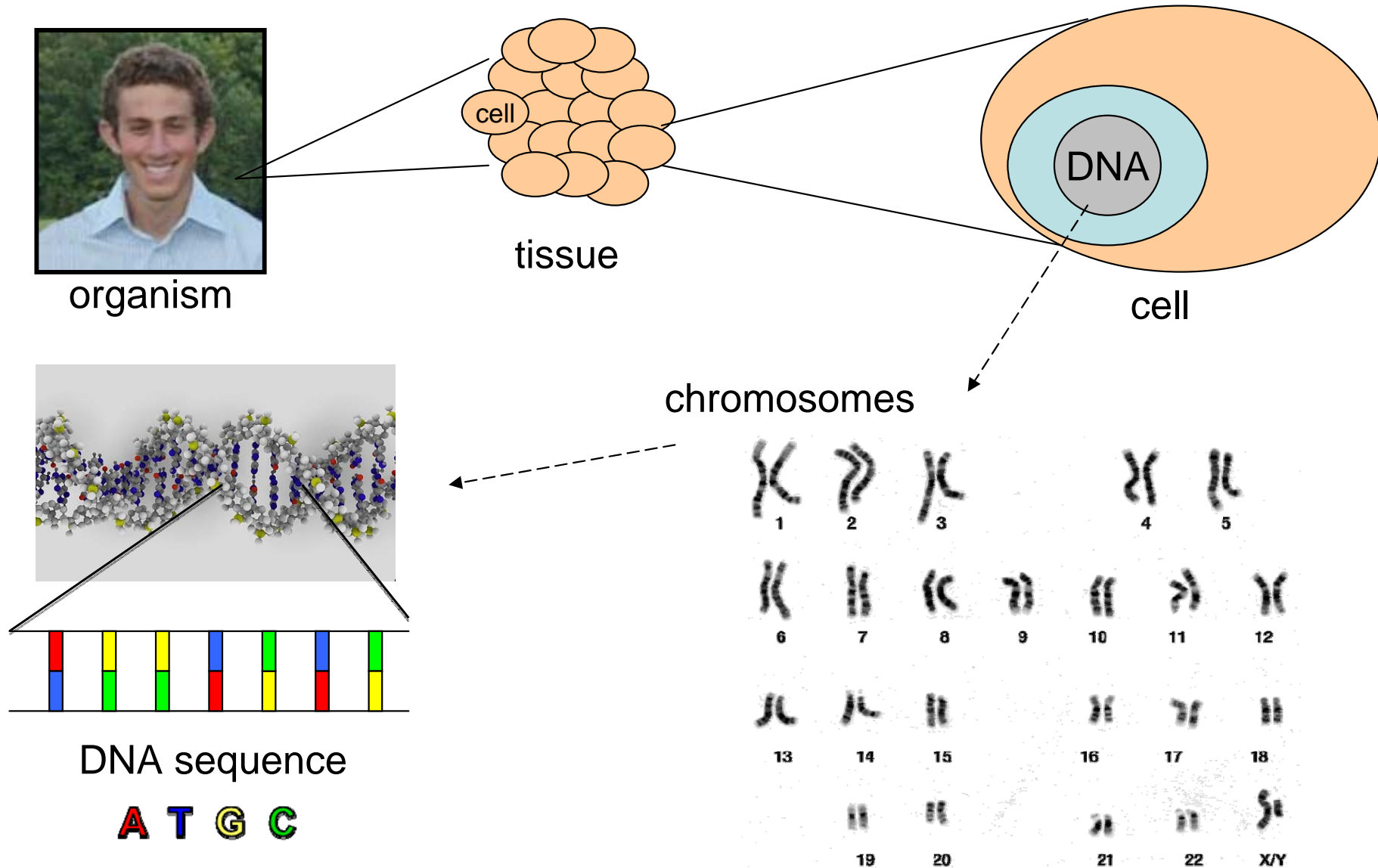


You Are What Your Mother Ate:

What is Epigenetics?

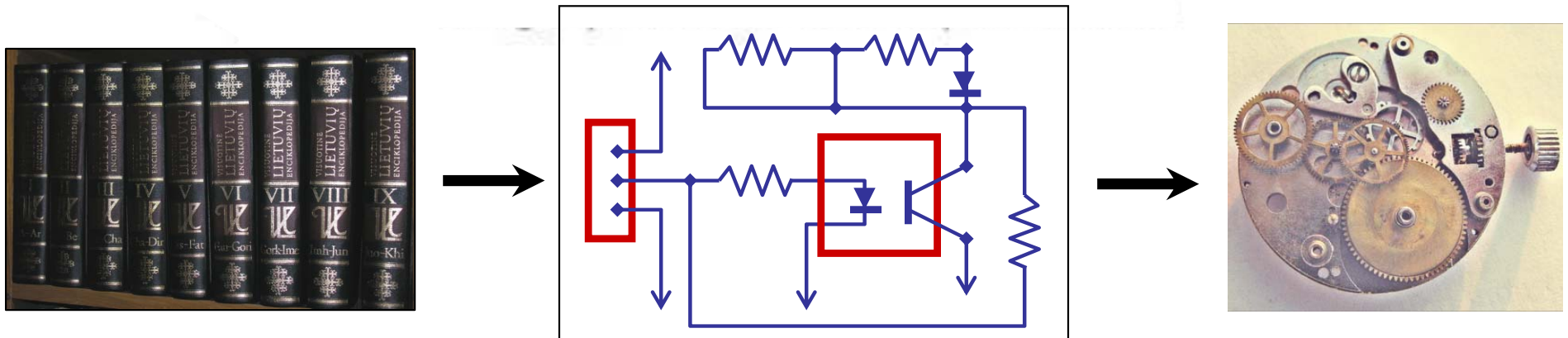
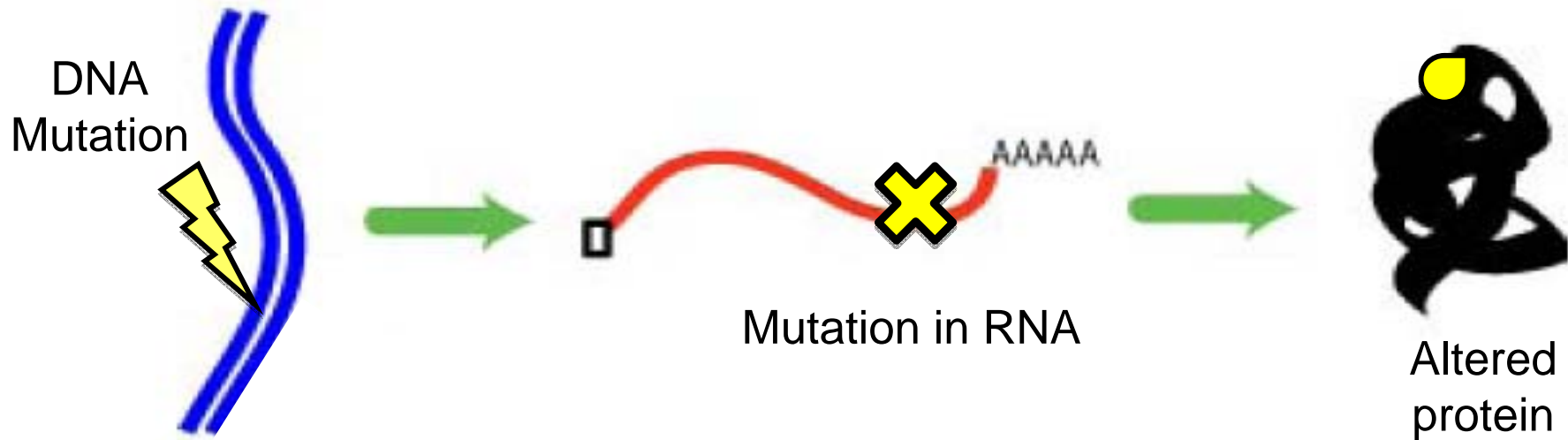
Daniel Lieber

DNA is the Source of Heritable Information in the Cell



Central Dogma

DNA is transcribed to **RNA** is translated to **PROTEIN**

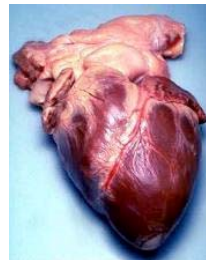
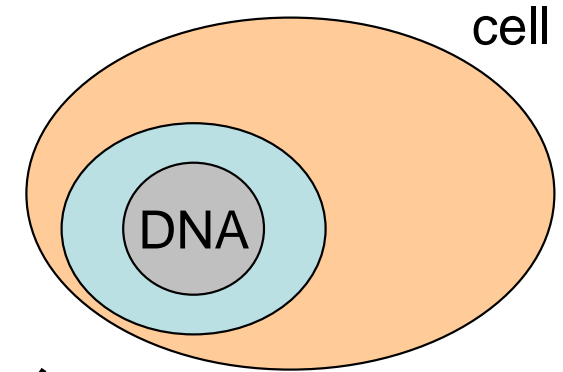


Same DNA, Different Look

- We are made up of over 200 cell types.
- Each cell has the same DNA!
- How can they look so different?

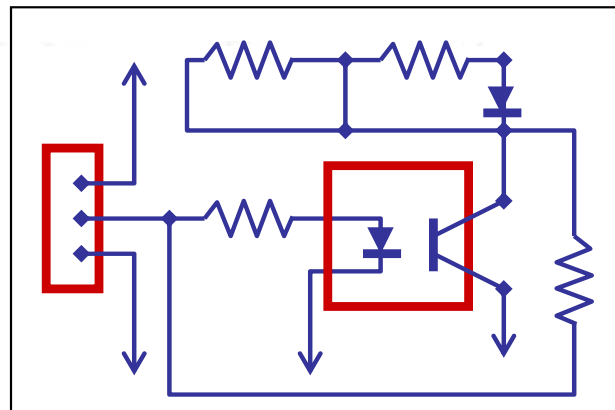
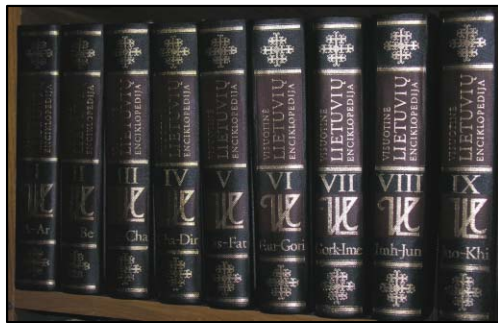
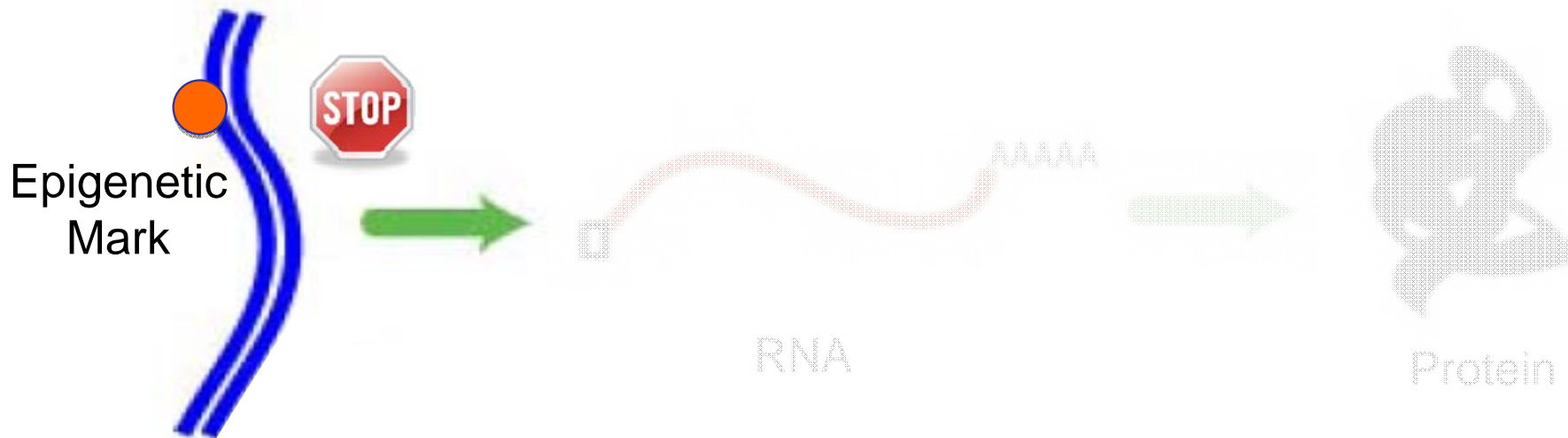
Epigenetics!

- Genes turned on or off



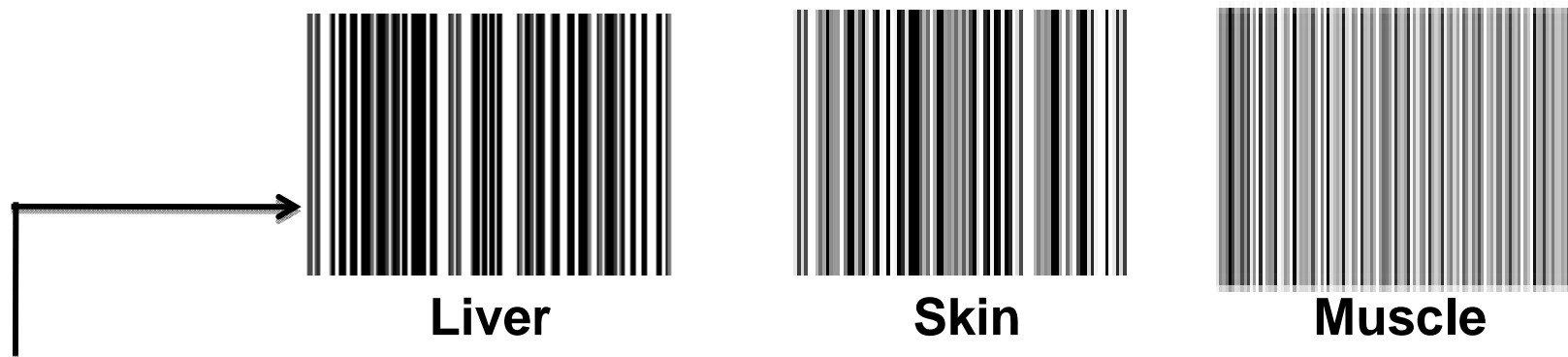
Epigenetic Marks

DNA is transcribed to **RNA** is translated to **PROTEIN**

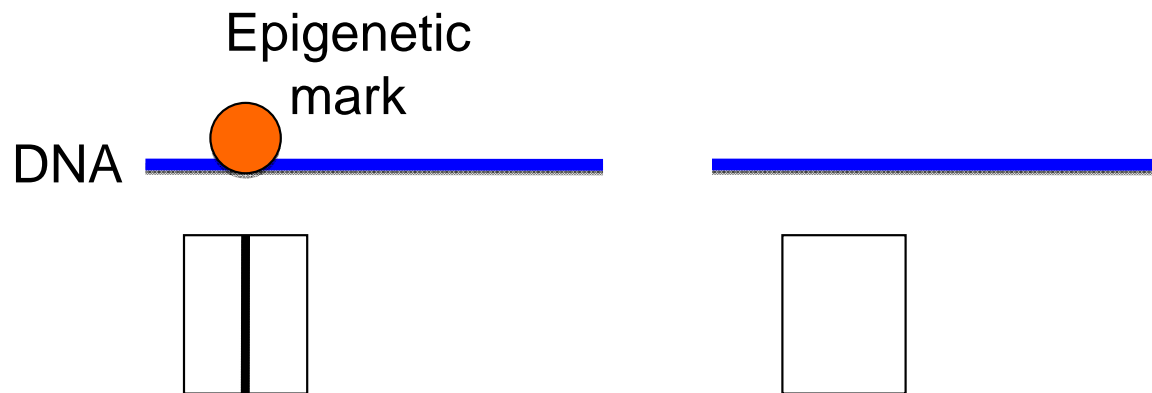


Each Cell has an Epigenetic Signature

- Epigenetic state is like a barcode:



Presence of an epigenetic mark at a particular location in the DNA

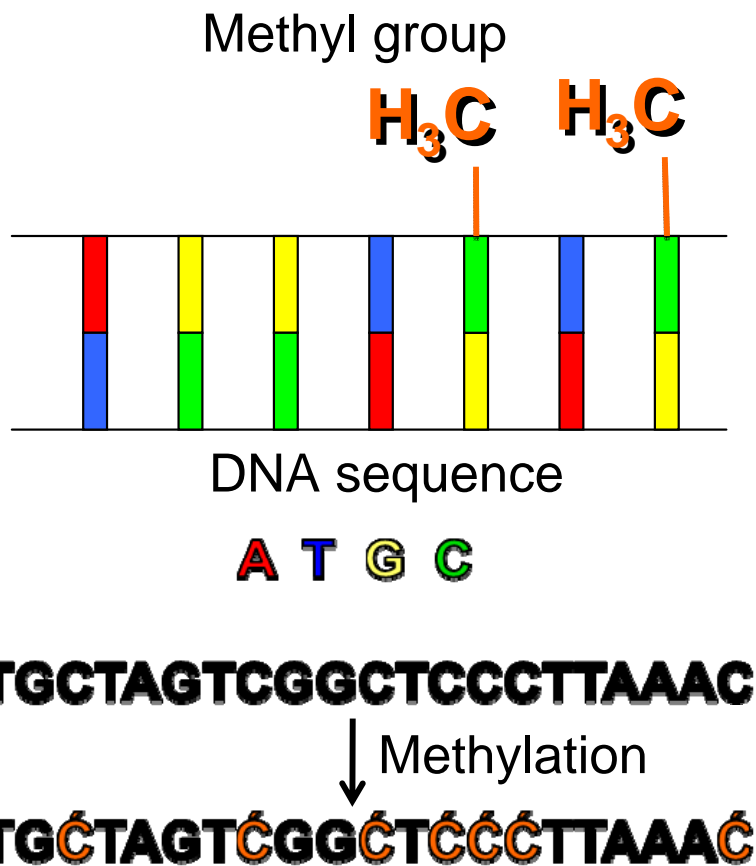


- Epigenome = complete epigenetic state of a cell

Two Types of Epigenetic Marks

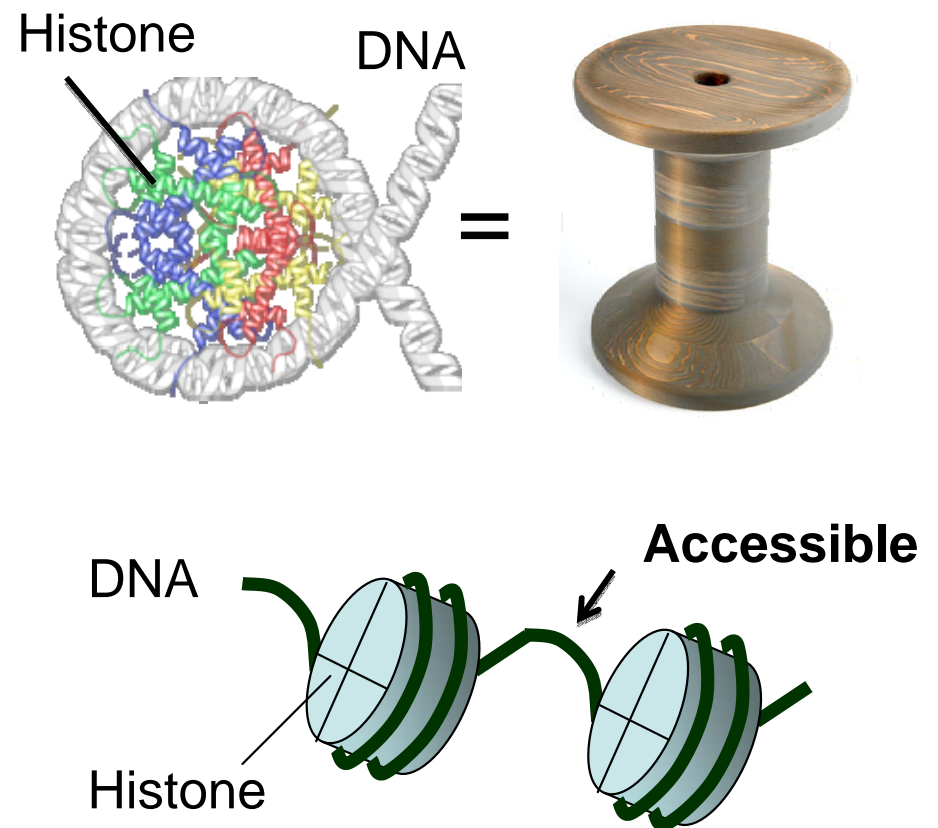
Chemical

e.g., Methylation



Protein

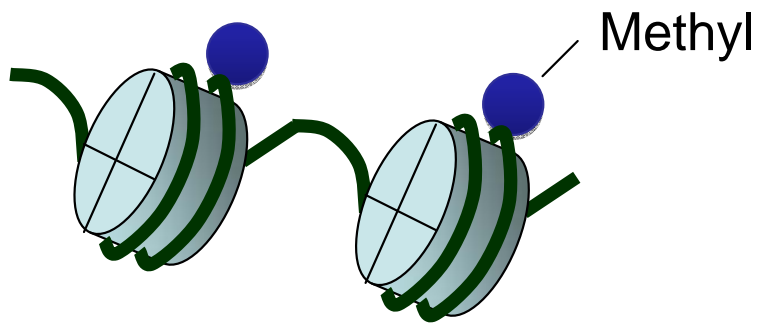
e.g., Histones



Combinations of Epigenetic Marks

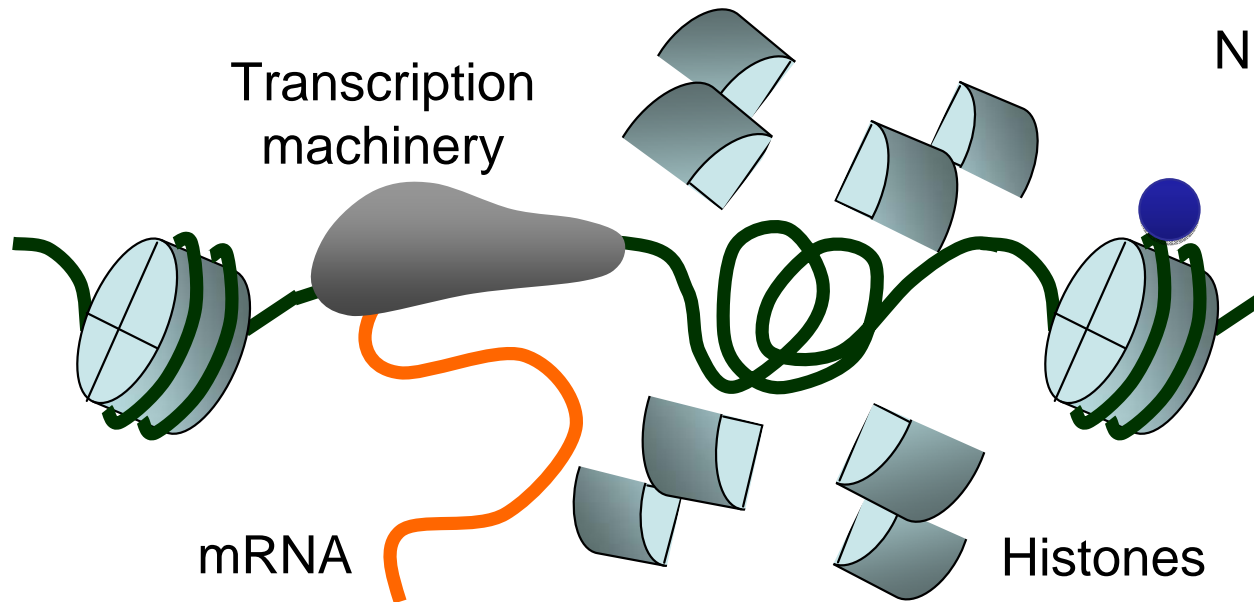
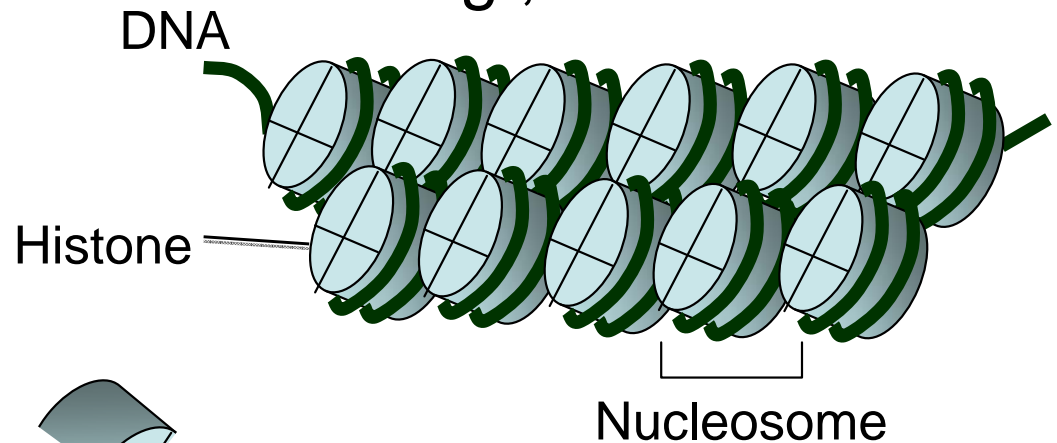
Chemical

e.g., Methylation



Protein

e.g., Histones



What do epigenetic marks do?

If DNA is like the alphabet,
epigenetic marks are like the
accents and **punctuation**

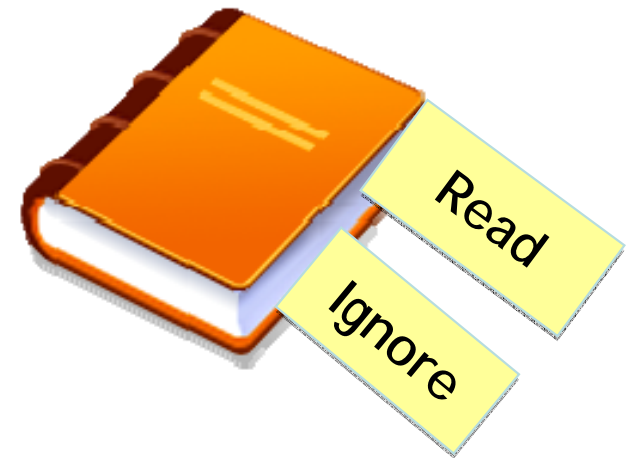
If DNA is like a book,
epigenetic marks are like
sticky notes

DNA sequence

TAG CAT ACT

TAG! **CAT?** **ACT**

Epigenetic marks

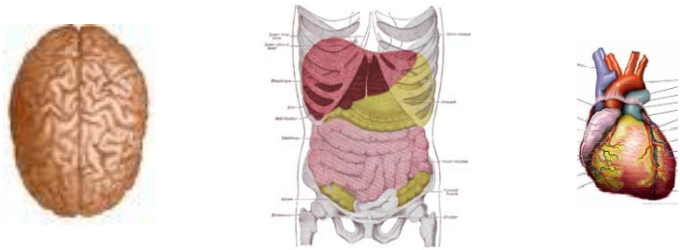


**Epigenetic marks tell our cells
whether and how to read the genes**

What is Epigenetics? (Formal Definition)

- Epigenetics is the study of inherited traits caused by mechanisms other than changes in the underlying DNA sequence.
- Epi- = “above” or “upon”
- Framework for answering:
 - How can the same DNA sequence lead to different outcomes?

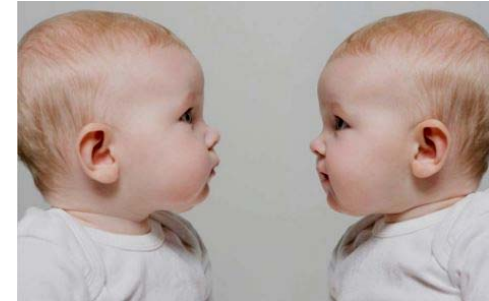
How Does Epigenetics Affect Us?



Tissues have different epigenetic states



Sisters? Actually, genetically identical.
Mothers were on different diets!



Diet and environment impact
your epigenetic state

Sources of Epigenetic Variation

Nature vs. Nurture

- Nature: Epigenetic marks can be inherited.
- Nurture: Epigenetic marks can be accumulated.
 - Only those in germ line will be passed down.



Nature



Nurture

Human (Epi)Genome Project

- Human Genome Project (1990-2003)
 - Sequenced all ~20,000 genes in our DNA
 - 3 billion basepairs, ~3 billion dollars
 - Only 1.5% of genome codes for proteins!
- Epigenomics Road Map (2008-Present)
 - Goal: Create map of epigenome in multiple tissue types and cancers



Summary

- Epigenetics is the study of heritable changes in gene activity that do not involve alterations to the genetic code
- Epigenetic marks tell your genes to switch on or off
- Two types of marks: chemical (e.g., methylation) or protein (e.g., histones)
- Through epigenetic marks, environmental factors like diet, stress and prenatal nutrition can make an imprint on genes passed from one generation to the next.
- Epigenetic changes can be inherited or accumulated
- Tissues have specific patterns of epigenetic modification

Thank you!

Questions?