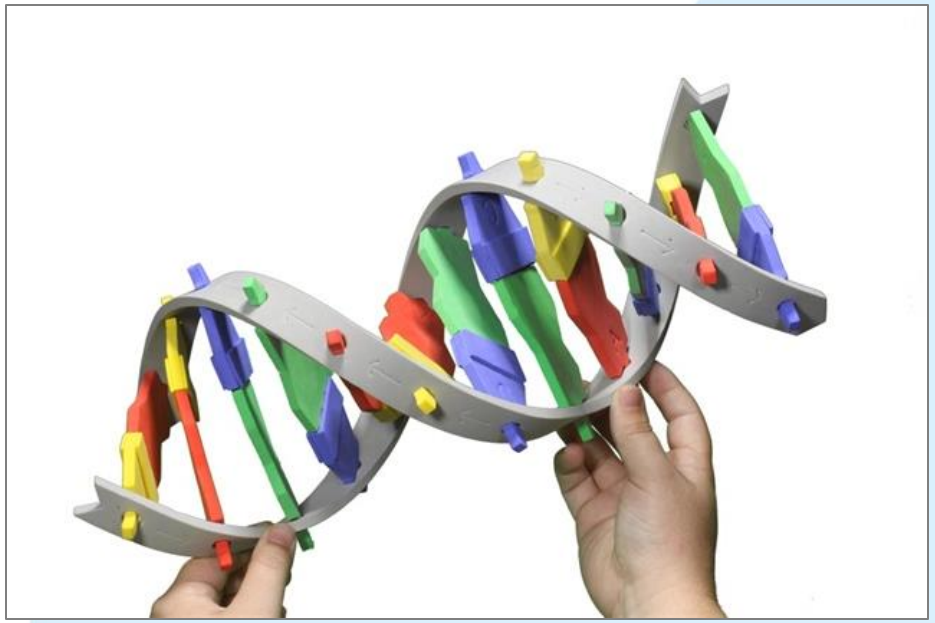
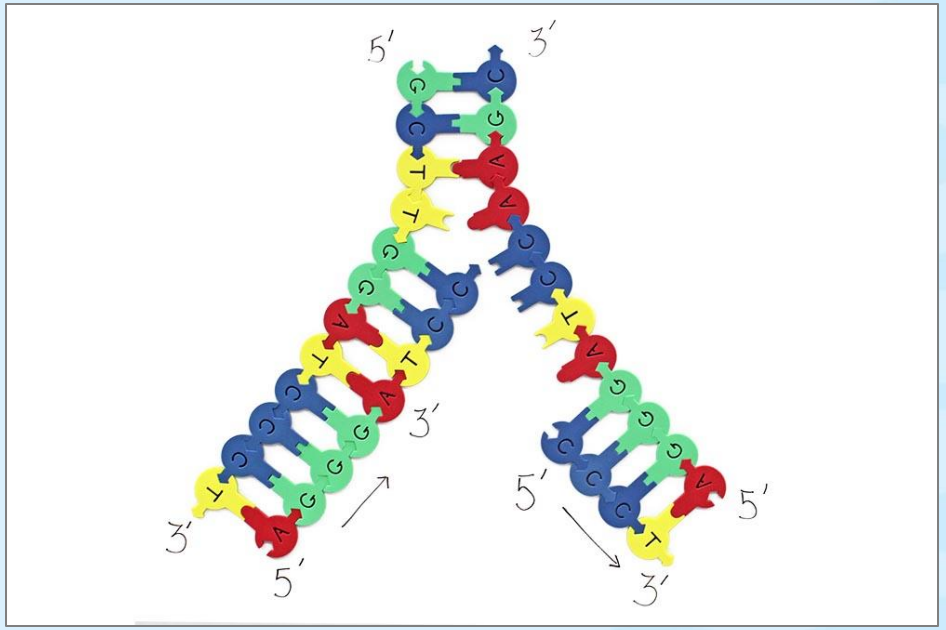
3d molecular designs
Transforming Science Learning

DNA With a Twist!

Use of Multiple Models in the Classroom





Mark Arnholt

Science Educator

SMART Team Coordinator

3D Molecular Designs

Milwaukee, WI

mark.arnholt@3dmoleculardesigns.com

24 years of classroom experience

PLTW BMS Certified (PBS, MI, BI)
Cohort Biology
General Biology (9-10)
Anatomy and Physiology
Biotechnology, Bacteriology, and Genetics
Physical Science(9)
Aviation

After school activities

New Teacher Mentor
SMART team advisor
Wrestling coach
Fishing club advisor

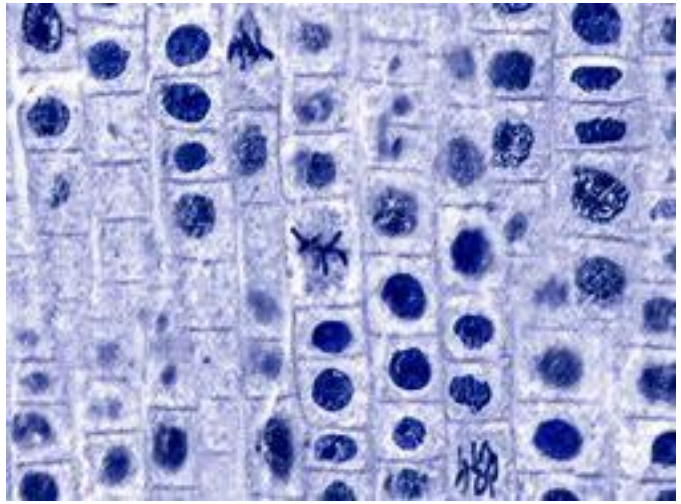
Awards:

Outstanding Science Educator - University of Minnesota – Twin Cities
2014
Educator of the year HUHS
2015
Herb Kohl Fellowship Grant
2016

Workshop Learning Goals

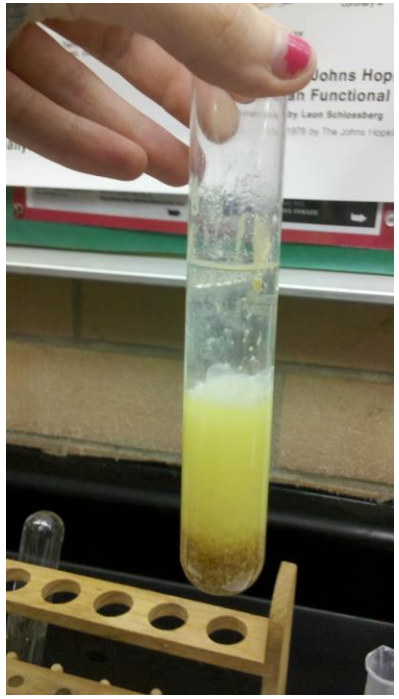
1) Facilitate DNA exploration and question generation
2) Use multiple models to develop a deeper understanding of DNA structure
3) Discover other uses of the DNA Starter Kit, Dynamic DNA, and DNA Demo Nucleotides
4) Have fun!

What does DNA look like?



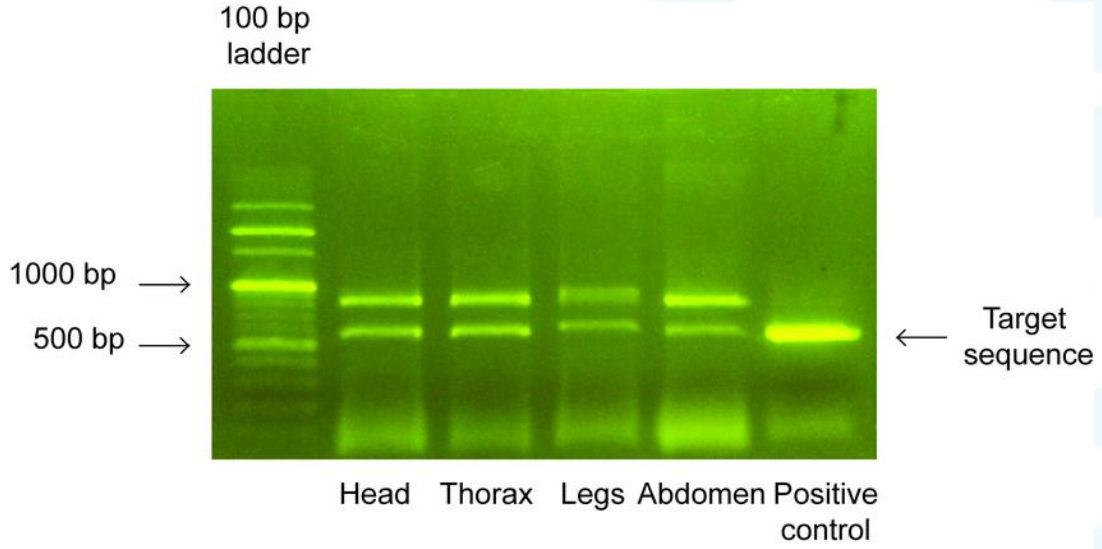
Under a microscope

[Onion Root Tip Photograph by Joseph F. Gennaro Jr. | Fine Art America]



In the lab

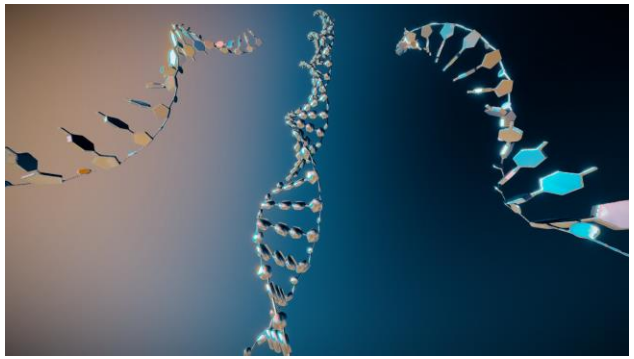
[Chapin's Bio Blog: DNA Extraction from Wheat Germ]

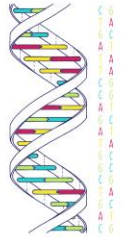


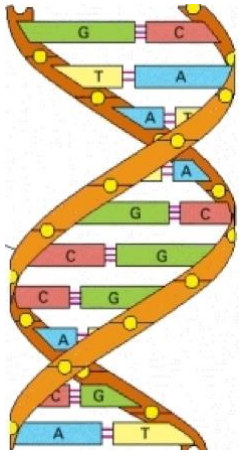
In a gel

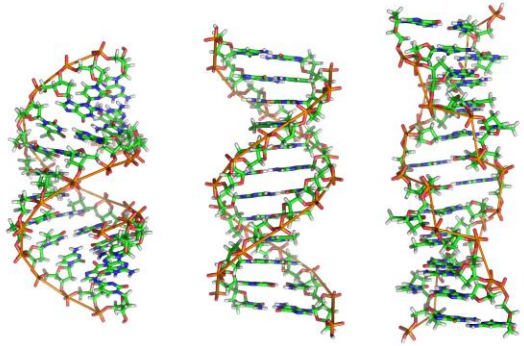
[Gel electrophoresis of 16S gene amplified in four genomic DNA samples... | Download Scientific Diagram (researchgate.net)]

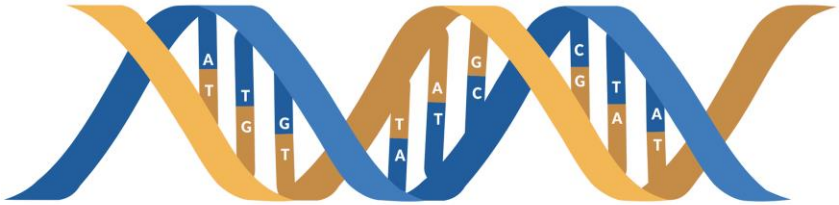
What model(s) of DNA do you use with your students?

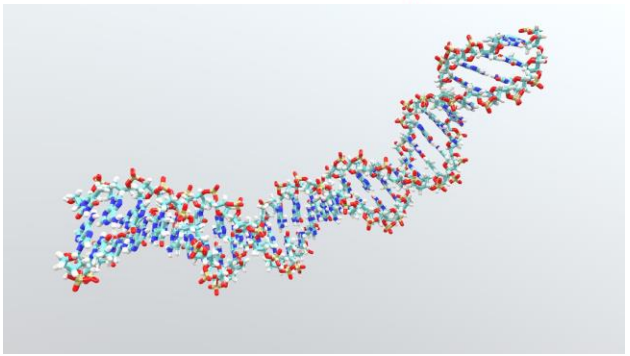


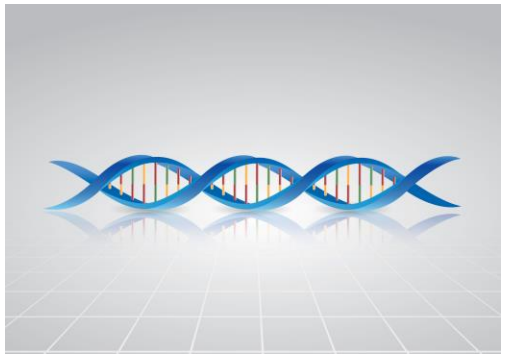




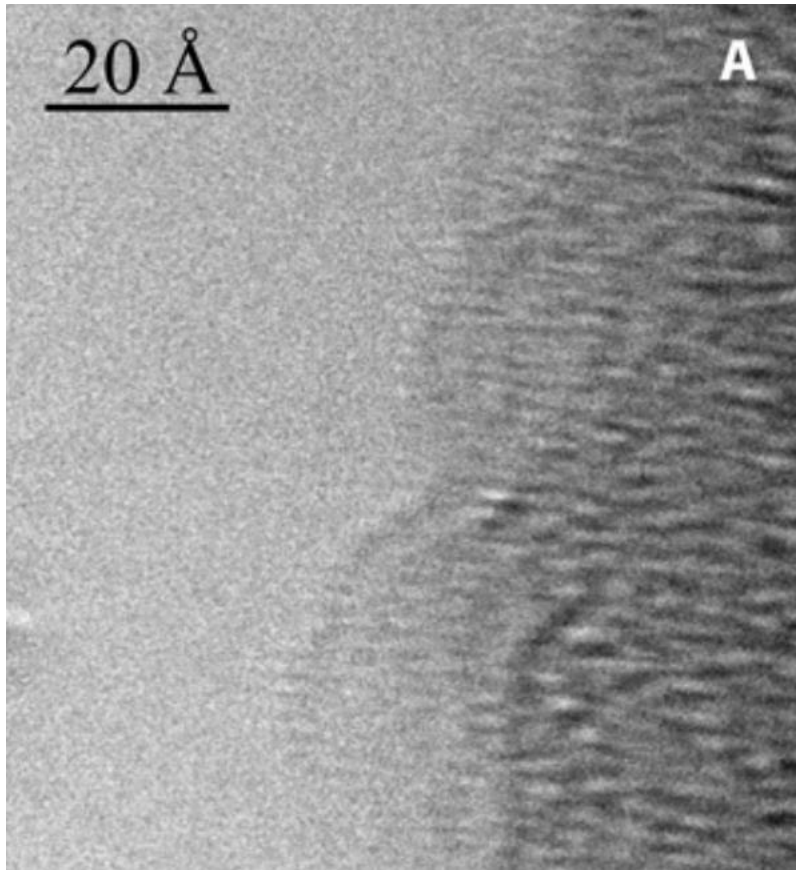


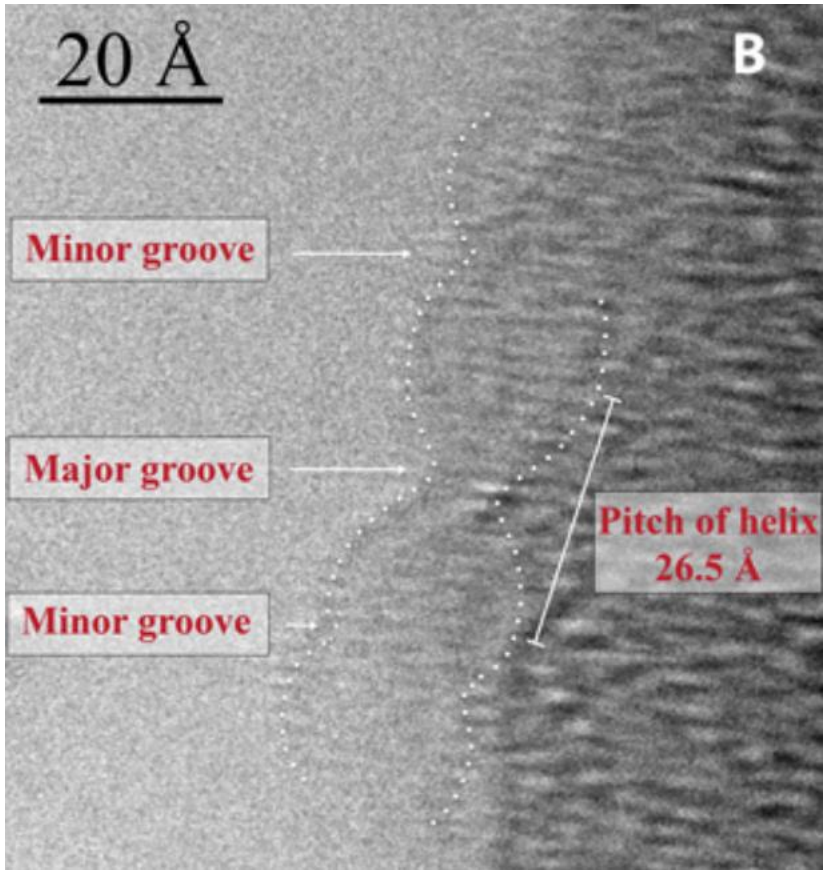






A “Photo” of DNA?





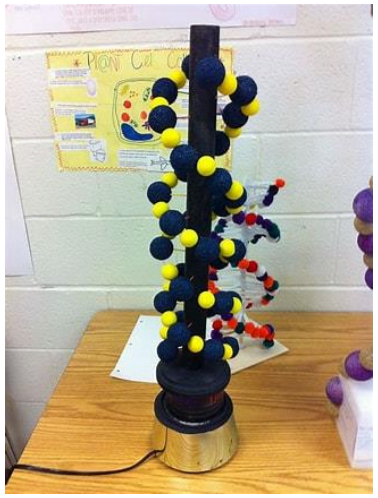
[The structure of DNA by direct imaging | Science Advances]

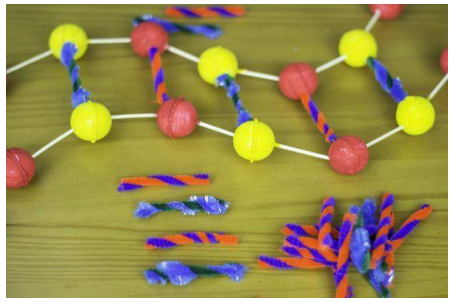
Essentially, all models are wrong, but some are useful.

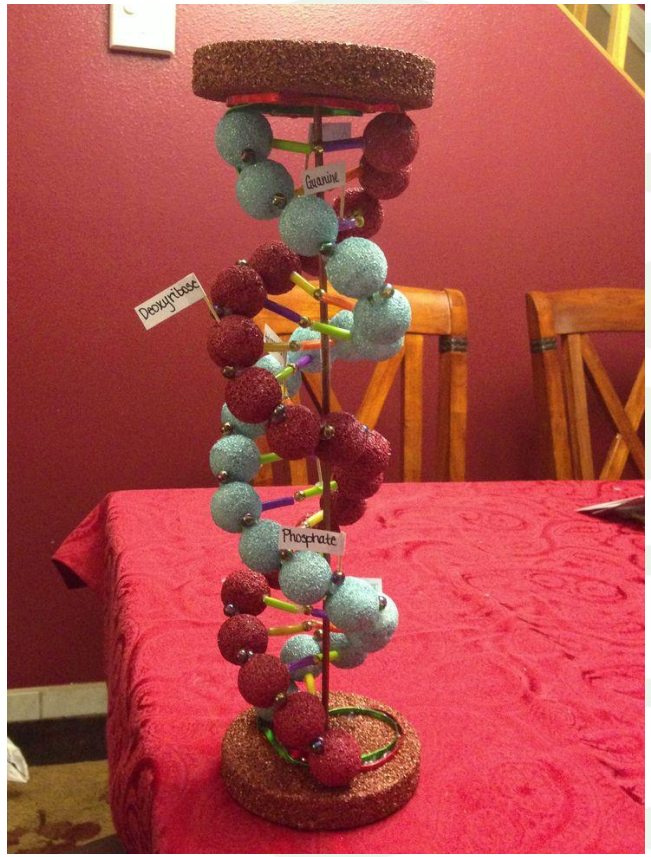
(George E. P. Box)

izquotes.com

So… we have students build models…

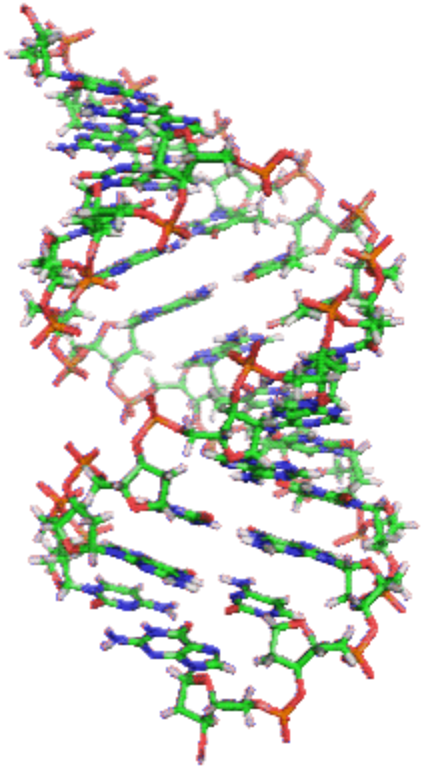


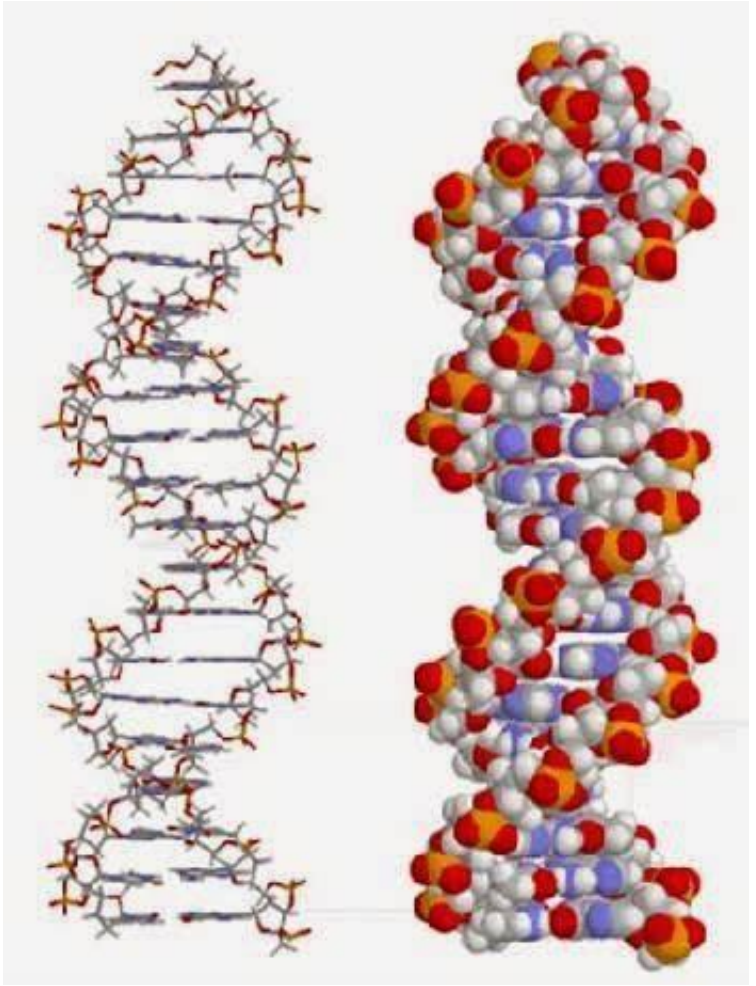


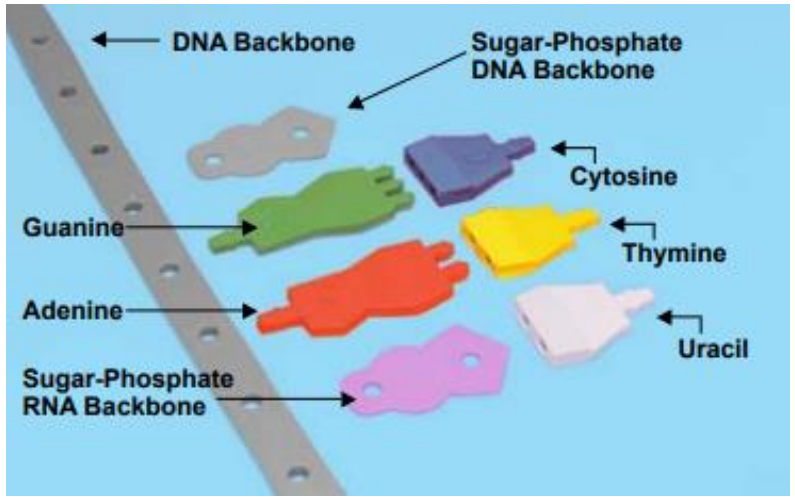


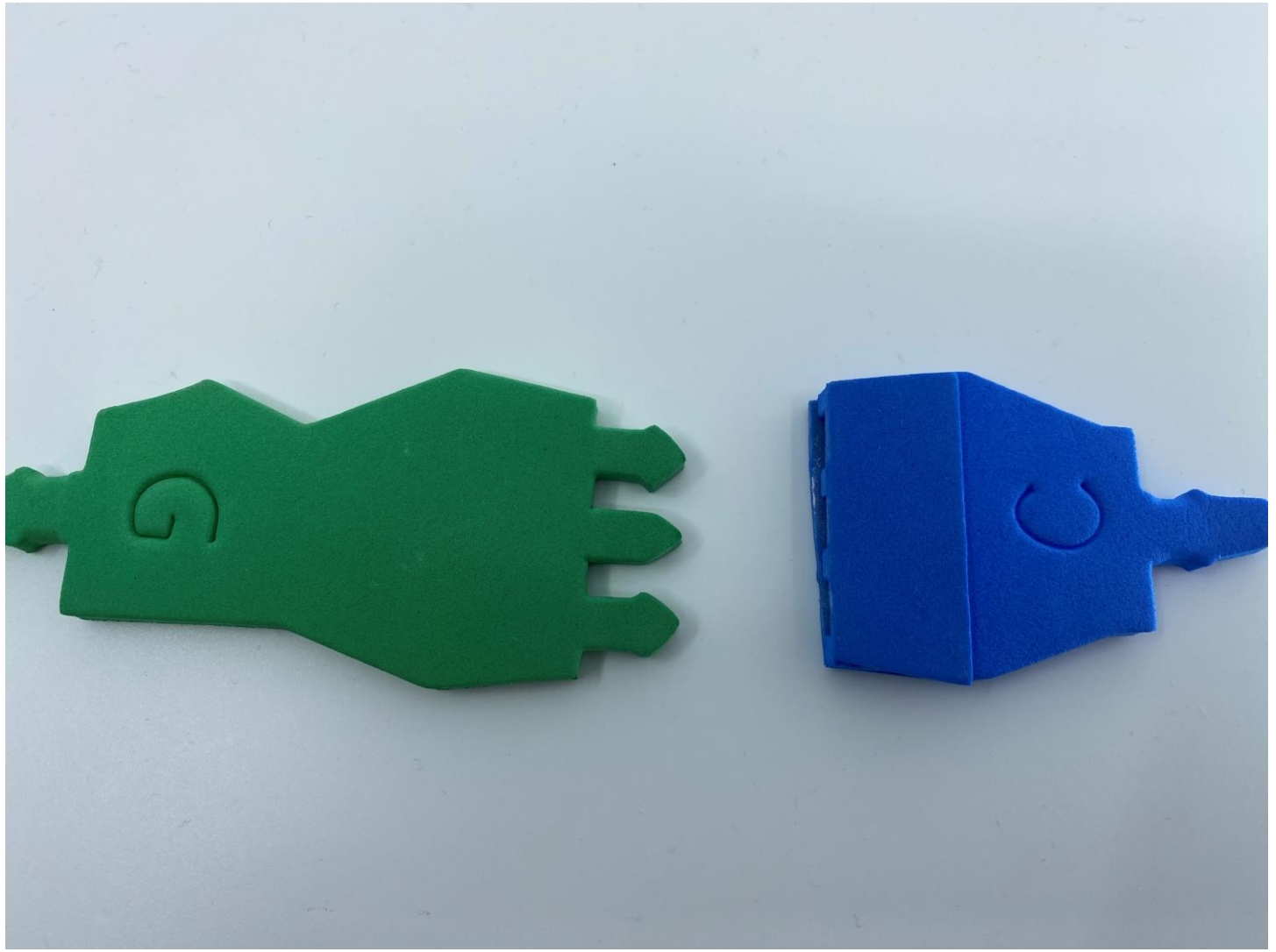
Caution!

- What do you want them to know?
- Different models show different things









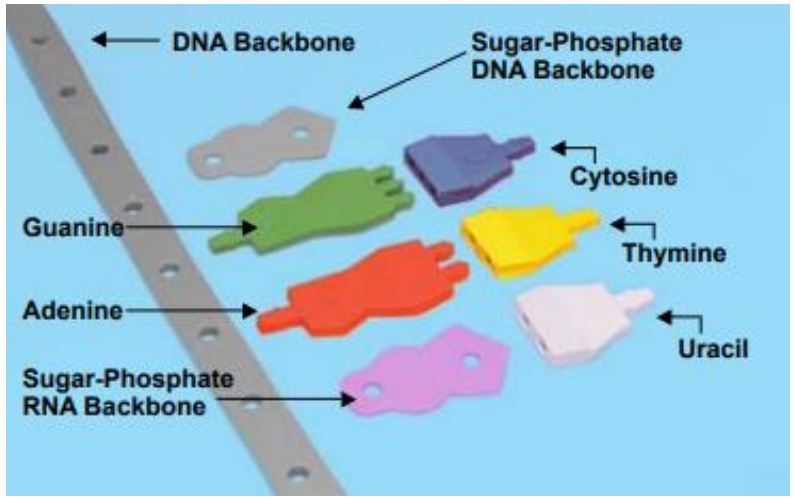
What do you notice about these 2 pieces?

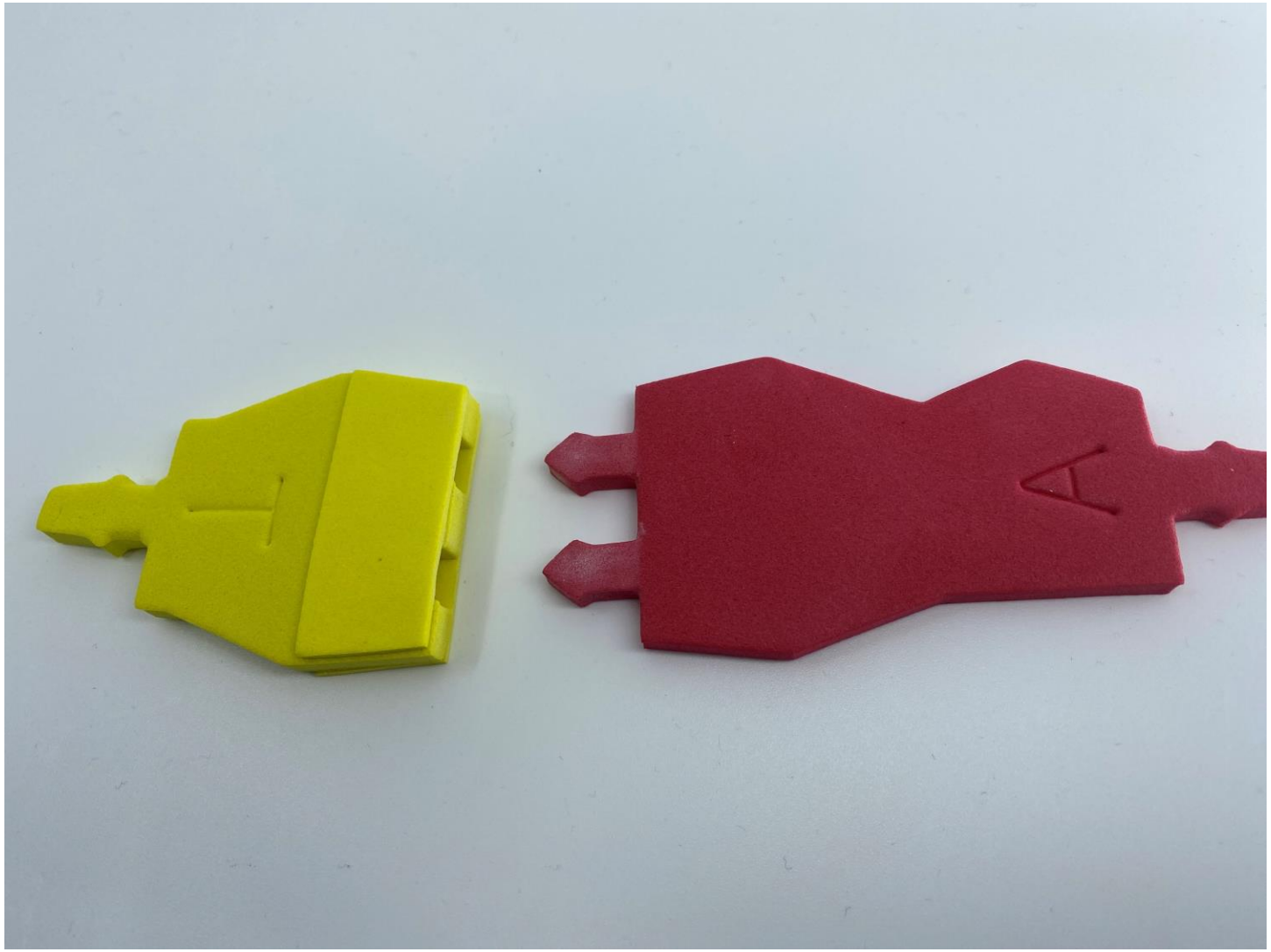
What questions do you think your students may have?

Purines – Pure As Gold
Pyrimidines – Pyramids CUT

Purine + Pyrimidine = 3 rings

Why is that important?





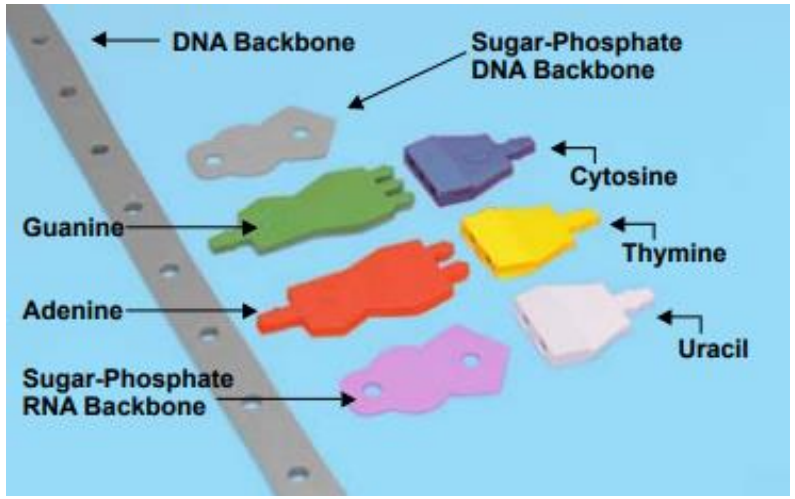
What do you notice about these 2 pieces?

What questions do you think your students may have?

Purines – Pure As Gold
Pyrimidines – Pyramids CUT

Purine + Pyrimidine = 3 rings

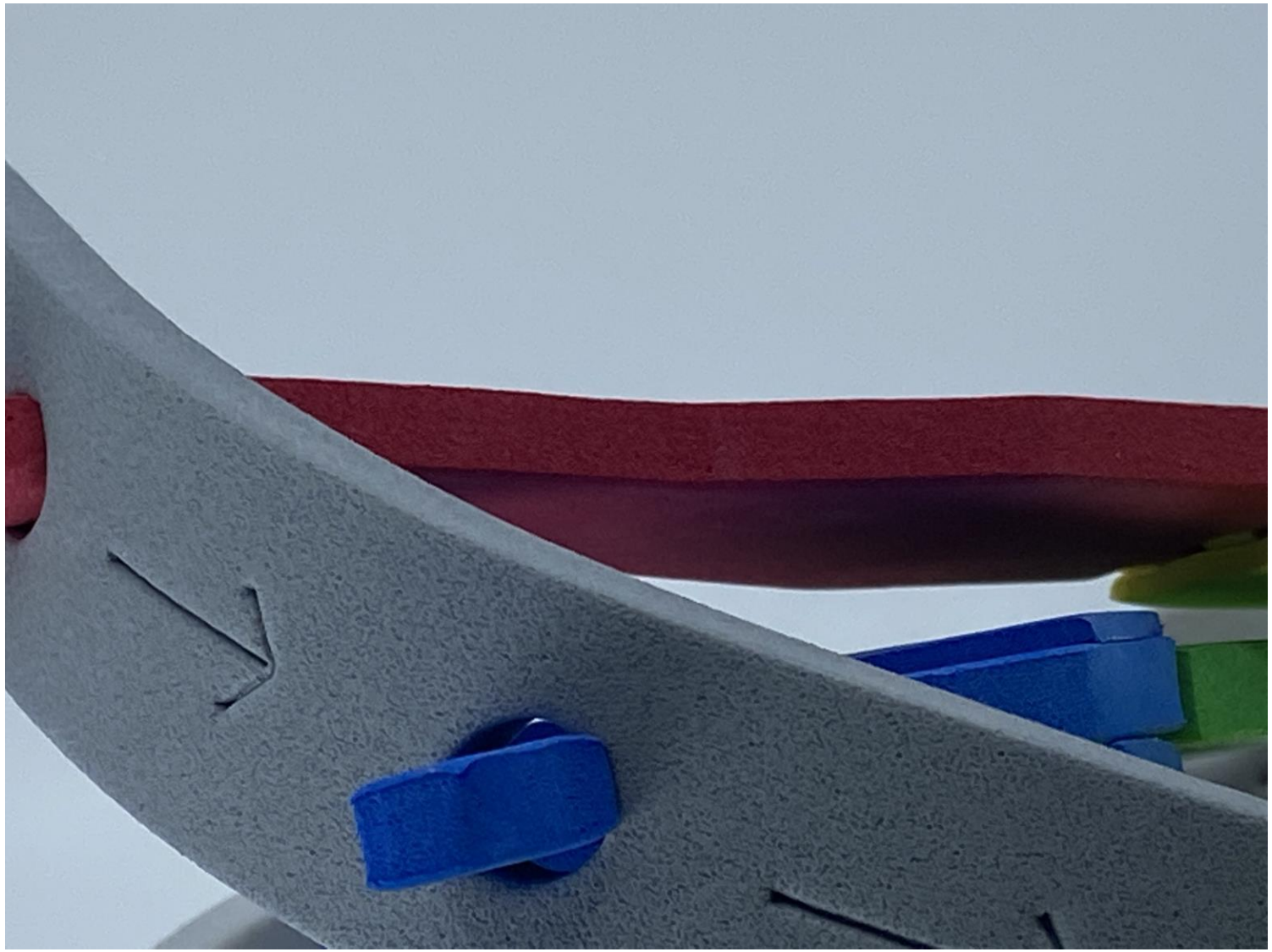
Why is that important?

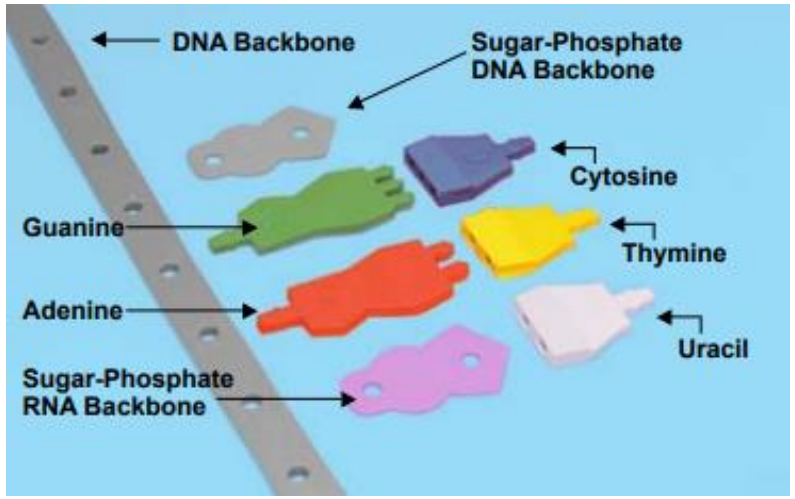


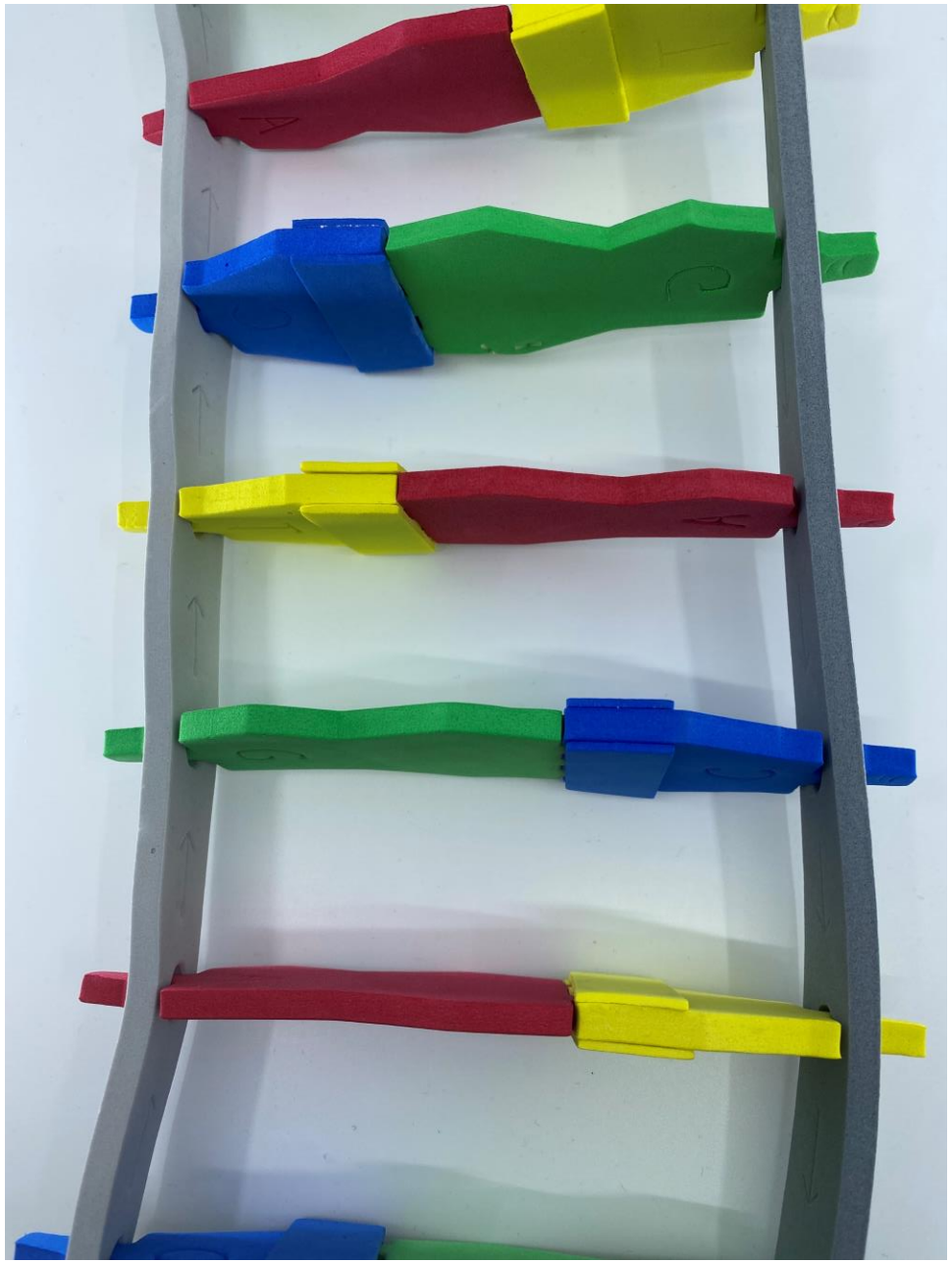
Look at the Backbone

What do the arrows represent?

5’ to 3’ -> Directionality
Antiparallel



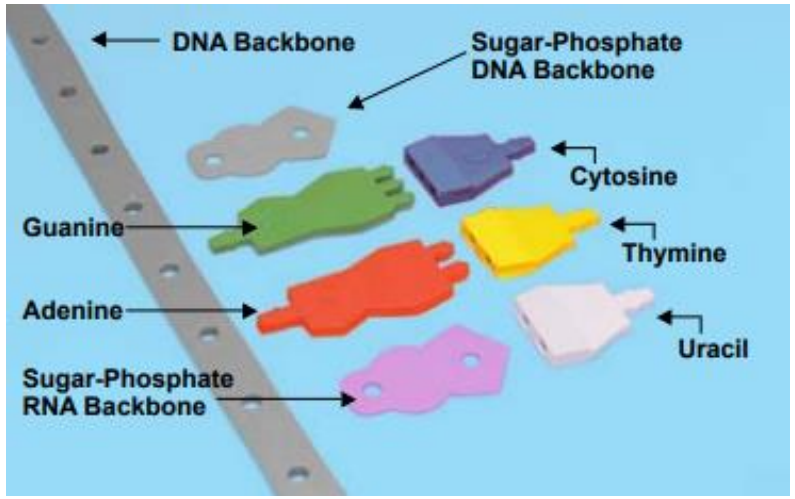




Look at the Backbone

What do the arrows represent?

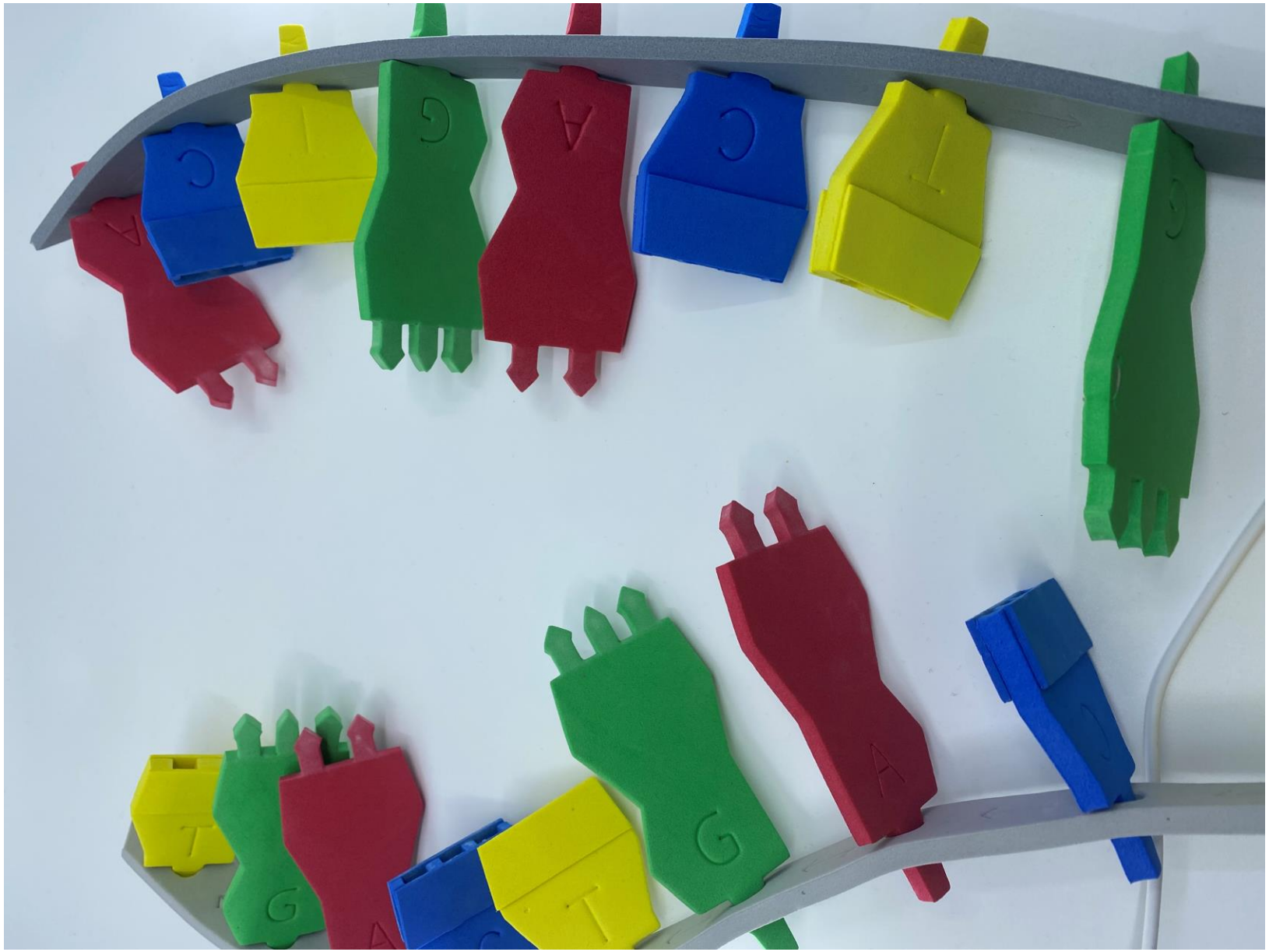
5’ to 3’ -> Directionality
Antiparallel



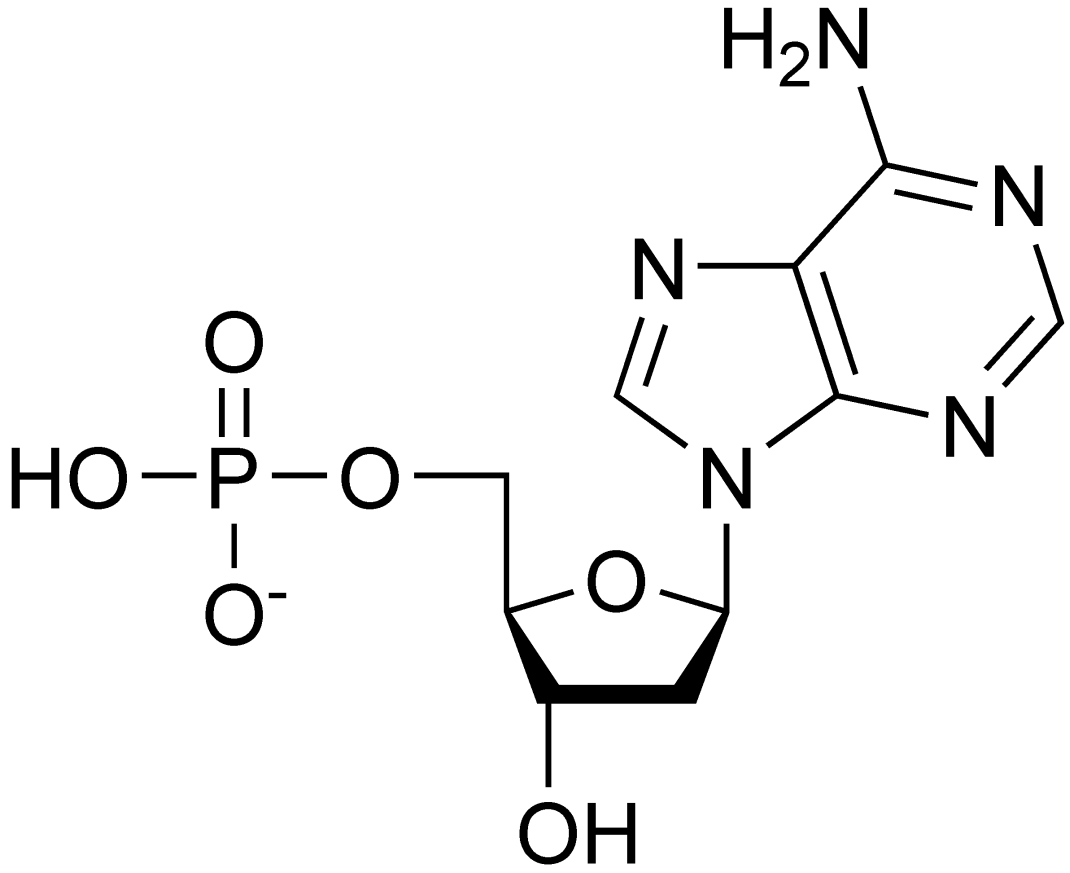
Look at the Backbone

What do the arrows represent?

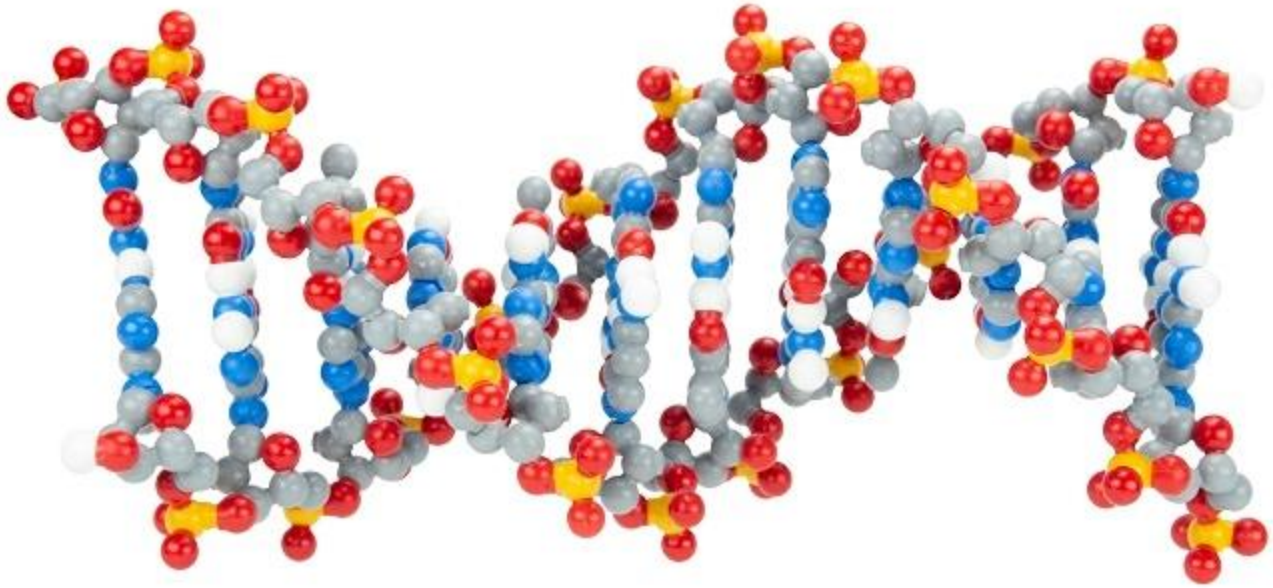
5’ to 3’ -> Directionality
Antiparallel

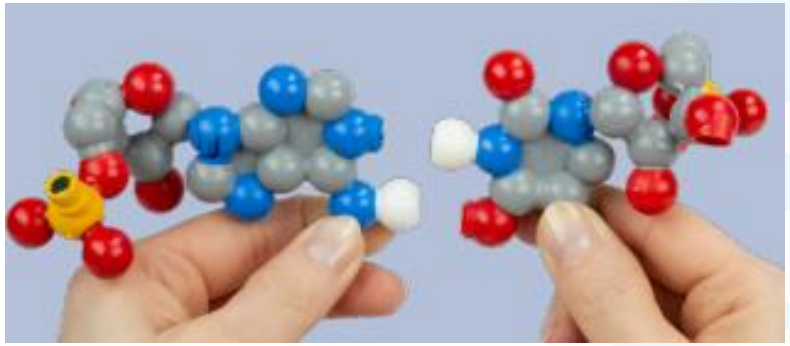

C
T
G
A
C
T
G
A
T
G
A
G
T
A
T

- Let’s look at a single nucleotide.
- What are some observations you can make?

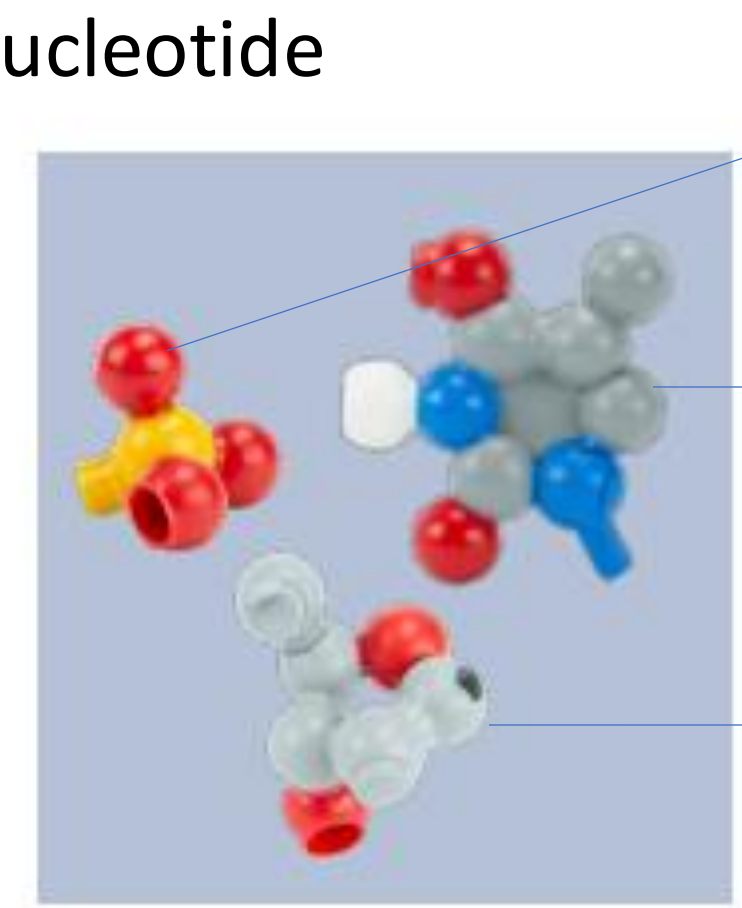


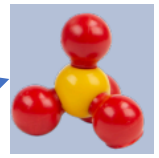
We need another model!



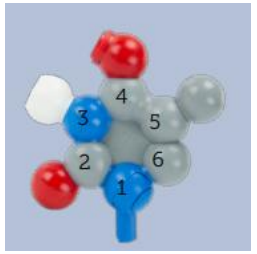


Let’s deconstruct a single nucleotide

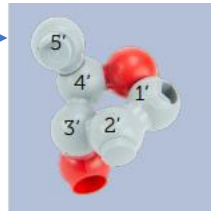




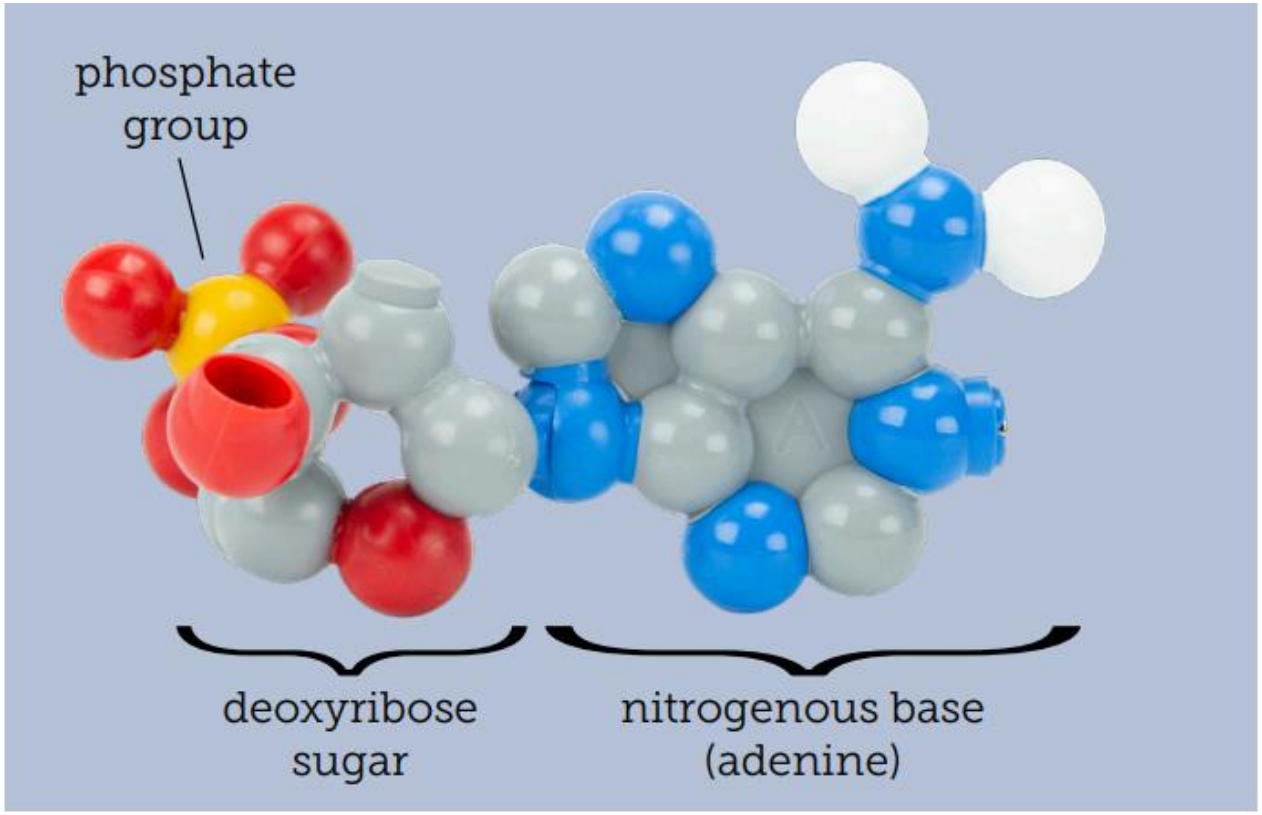
Phosphate group

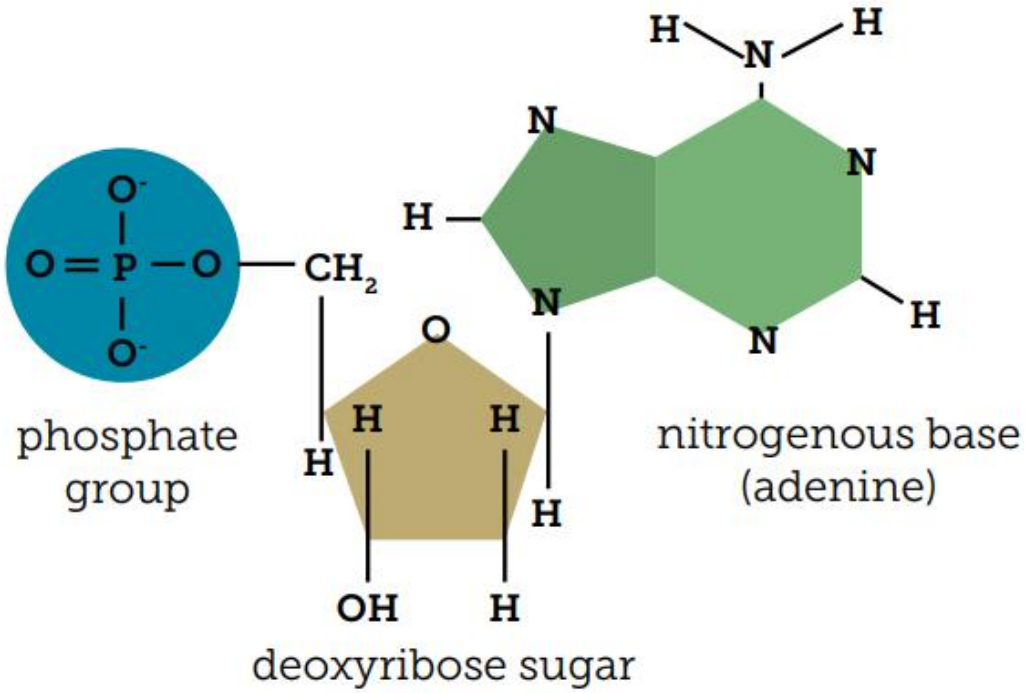


Nitrogenous Base (Thymine)



Sugar - Deoxyribose


phosphate group
deoxyribose sugar
nitrogenous base (adenine)


phosphate group
nitrogenous base (adenine)
deoxyribose sugar

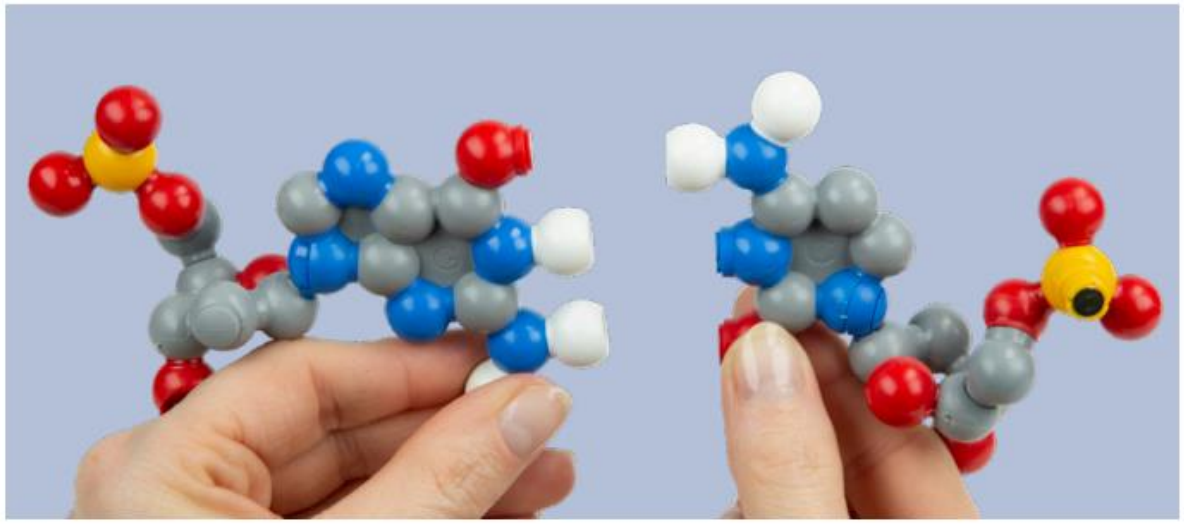
This model uses the CPK color scheme.

Carbon atoms: Grey
Oxygen atoms: Red
Nitrogen atoms: Blue
Phosphorus atoms: Orange

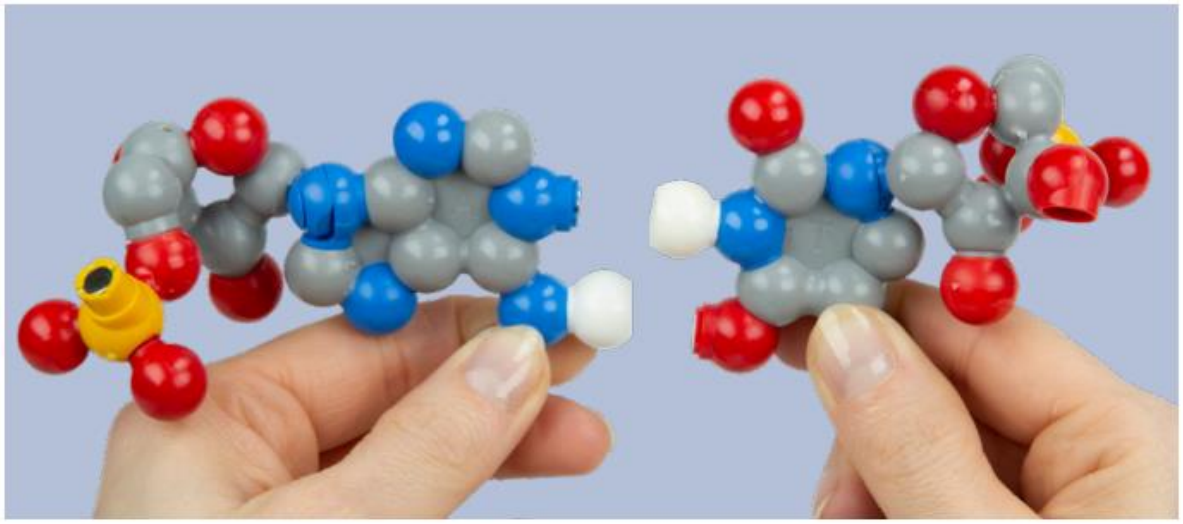
This was determined by Corey, Pauling, and Koltun
and can be used to determine if you are talking to a chemist or biochemist

“What color is a Carbon atom?”

Base pair with a complimentary nucleotide. A-T and C-G.



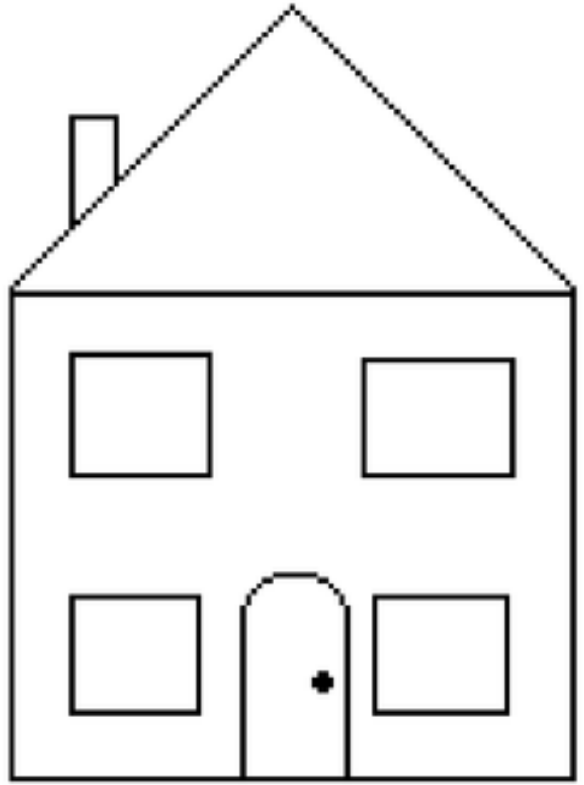
Three hydrogen bonds unite the G-C base pair.



Two hydrogen bonds unite the A-T base pair.

Notice the difference in the number of hydrogen bonds created.

How is Deoxyribose like a house?

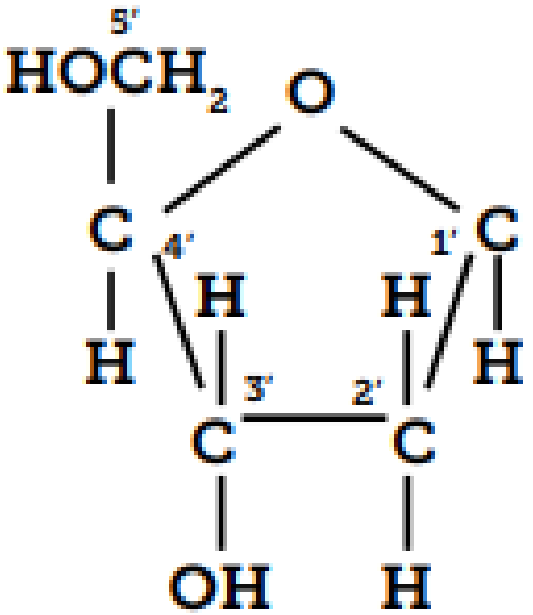


These are 2 different models of deoxyribose.

How are they similar?

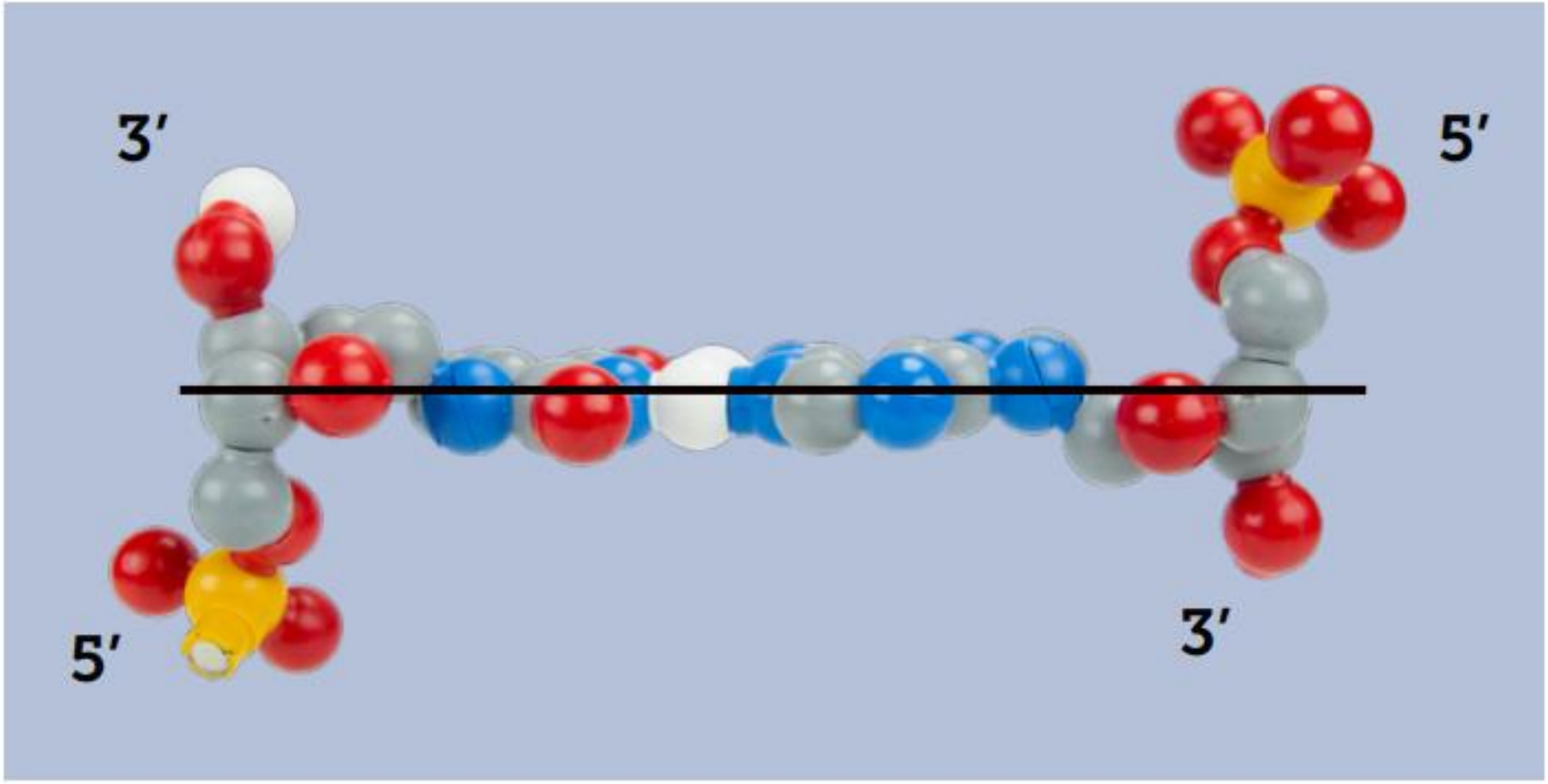
What makes them different?

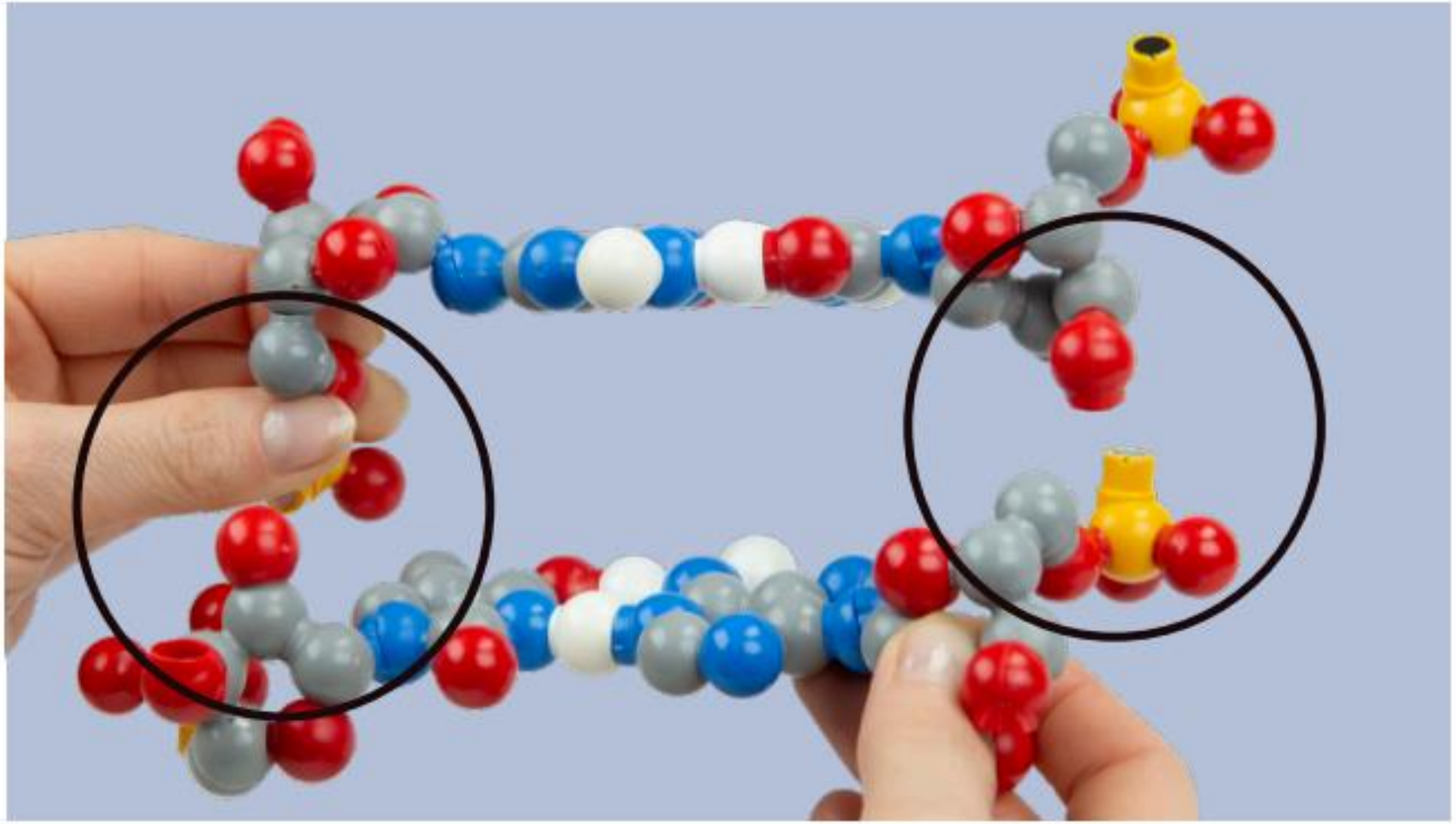
Which one is “better”?

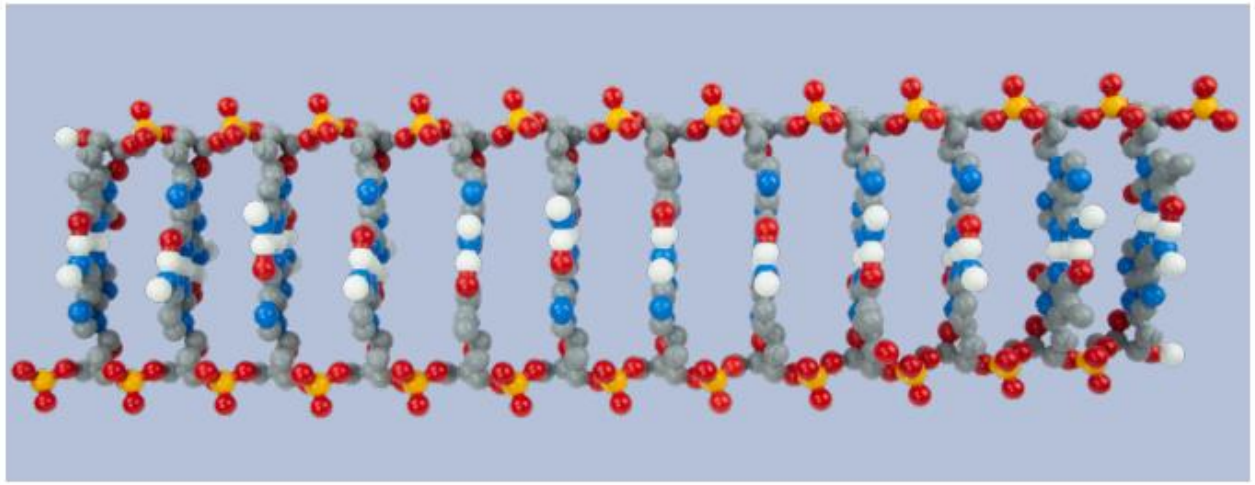


deoxyribose

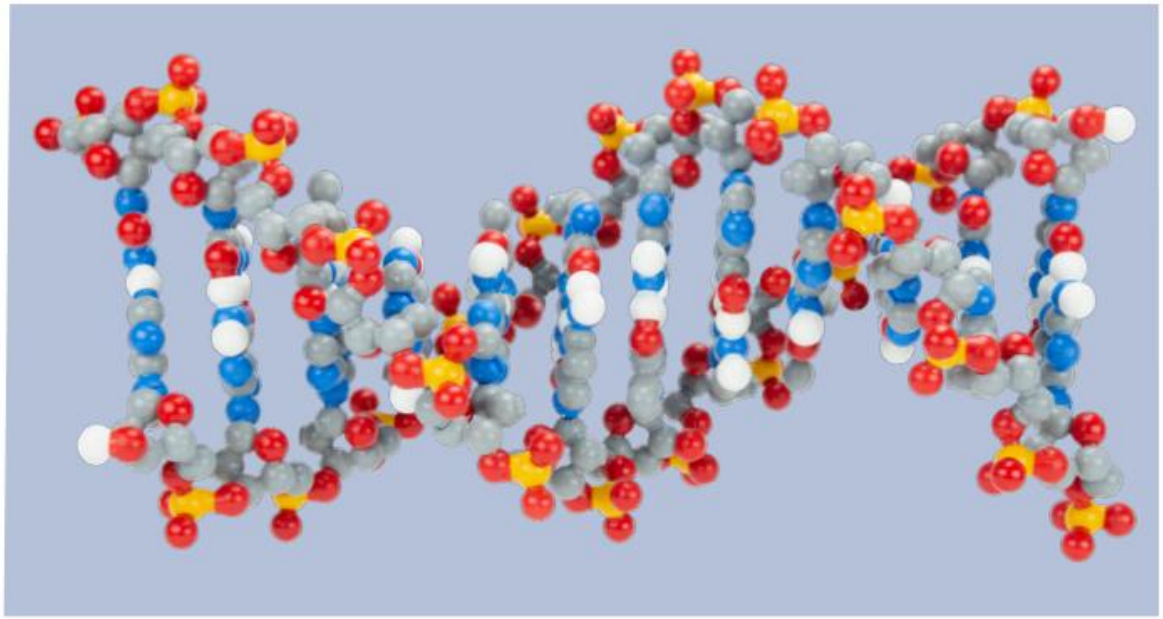
DNA is anti-parallel







Double helix-
Right-handed
Major / minor groove

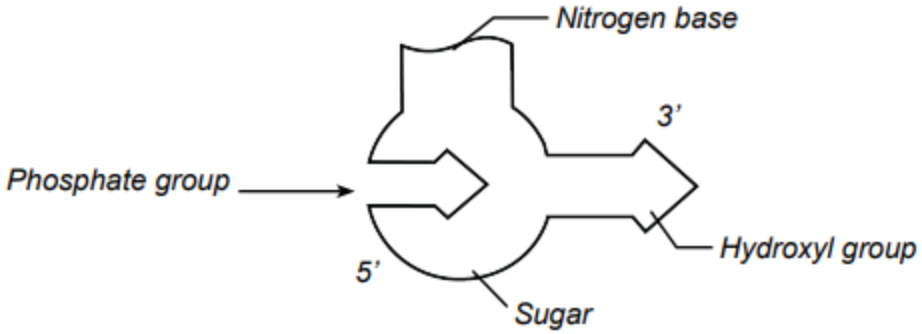


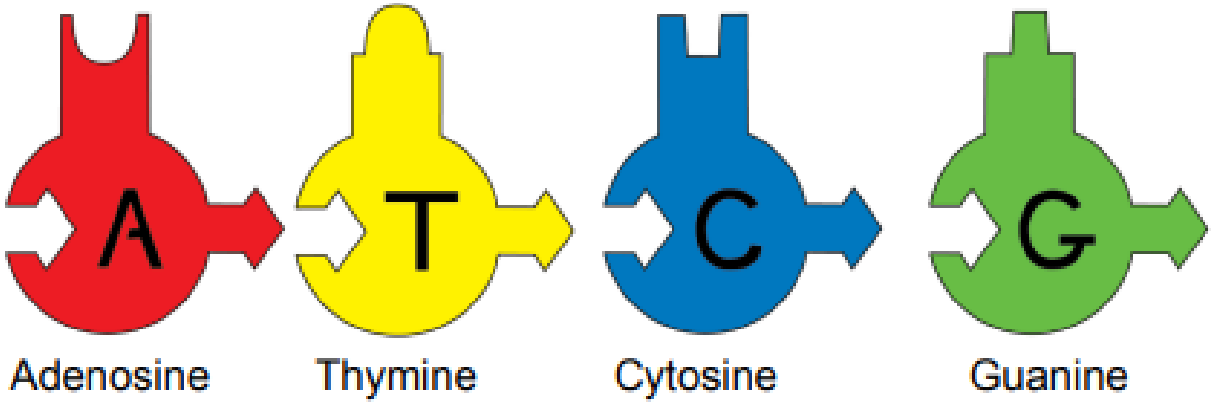
Linear format- Replication / Transcription
Directionality

What else could you teach with this model?

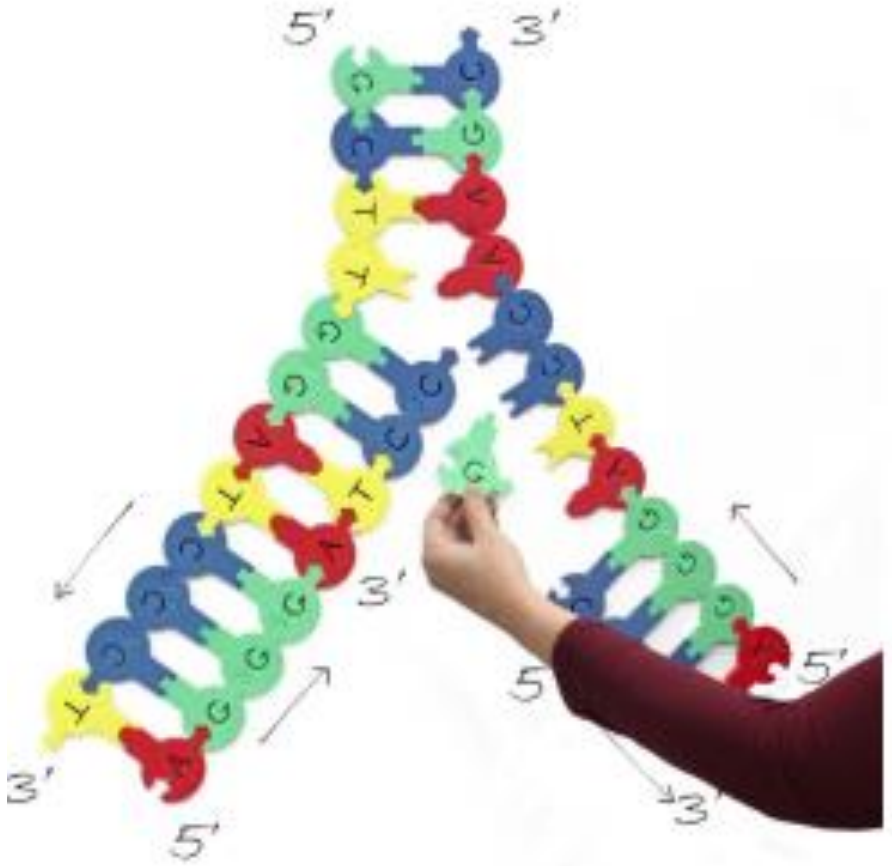
The nucleotide model

What does this model help your students focus on?

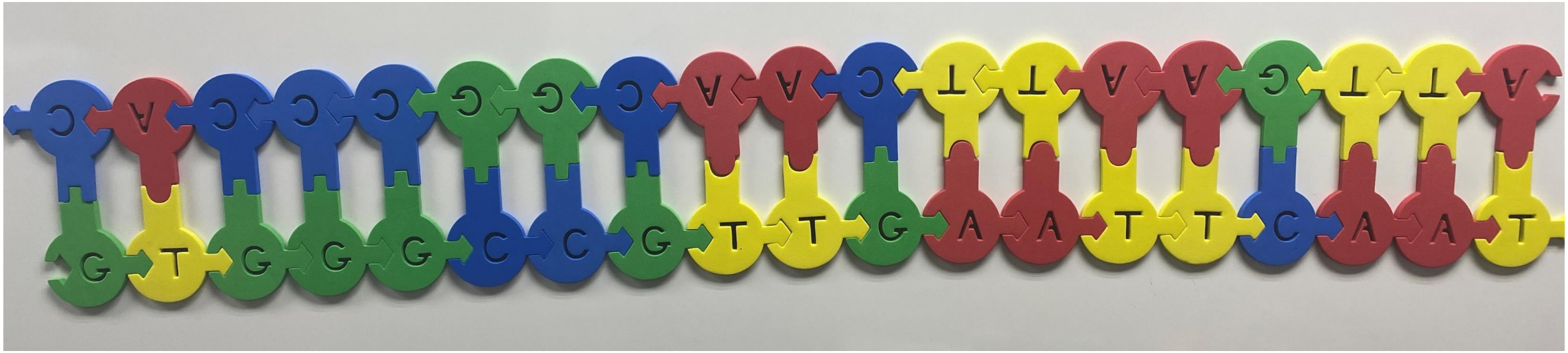




Replication with Direction!



Let’s Build a Sequence!



Restriction Enzymes!

2 Restriction sites are in your sequence. Use this to show Blunt vs Sticky ends. Ligations are also easily accomplished, along with the consequences!

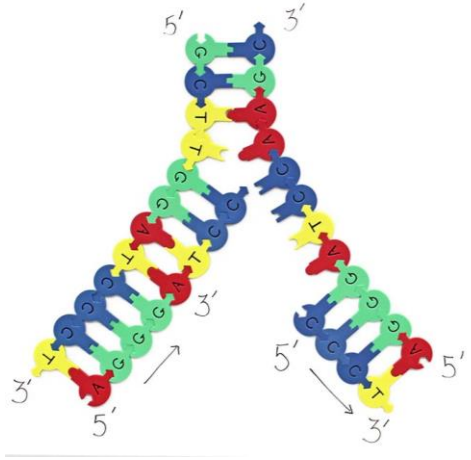
Workshop NGSS Connections

SEPs	CCCs	DCIs
Asking Questions and Defining Problems (HS-LS3-1)	Cause and Effect (HS-LS3-2)	Structure and Function (HS-LS1-1)
Developing and Using Models (HS-LS1-4)	Scale Proportion, and Quantity (HS-LS3-3)	
Analyzing and Interpreting Data (HS-LS3-3)	Systems and System Models (HS-LS3-3)	
	Science is a Human Endeavor (HS-LS3-3)	

THANK YOU FOR ATTENDING!

- Purchase kits at **3dmoleculardesigns.com**

Kits and models used in this session:



- Demo DNA Nucleotides ©
- Dynamic DNA©
- DNA Starter Kit ©

- Use discount code **FC22** to receive 20% off most items in our catalog. *Student Modeling Packs are not eligible for discount.*

3d molecular designs

Transforming Science Learning