

Discovering Dynamic DNA, More than Just A's and T's and G's and C's

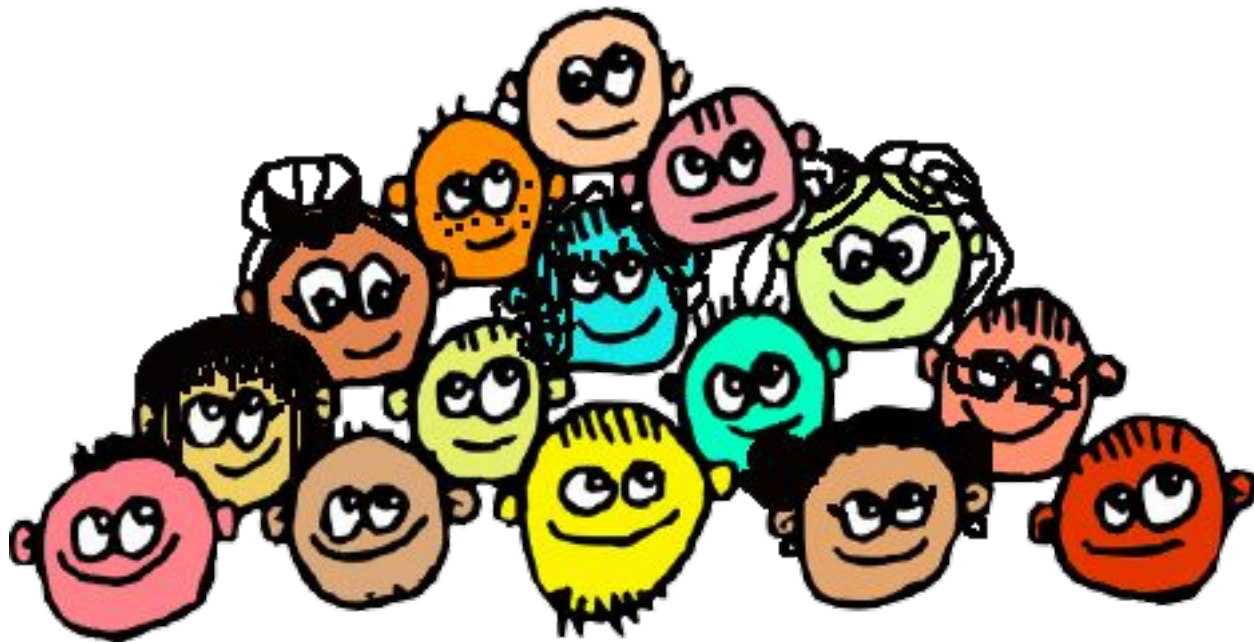


Keri Shingleton, Ph.D.

Who am I?

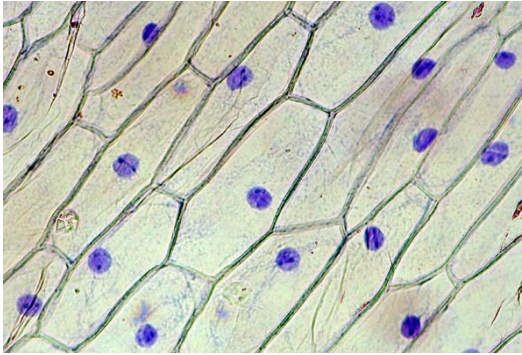


Who are you?





DNA UNDER A MICROSCOPE



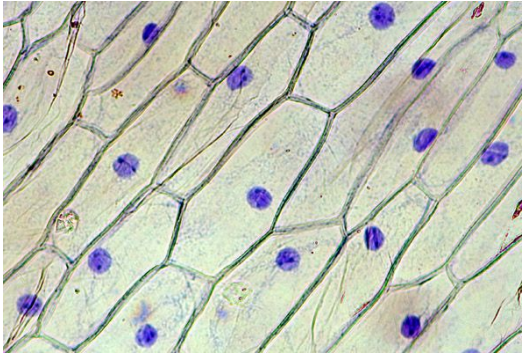
<http://www.microbehunter.com/wp-content/uploads/2009/onion1.jpg>

g





DNA UNDER A MICROSCOPE



<http://www.microbehunter.com/wp/wp-content/uploads/2009/onion1.jpg>

g

OR IN A TEST TUBE

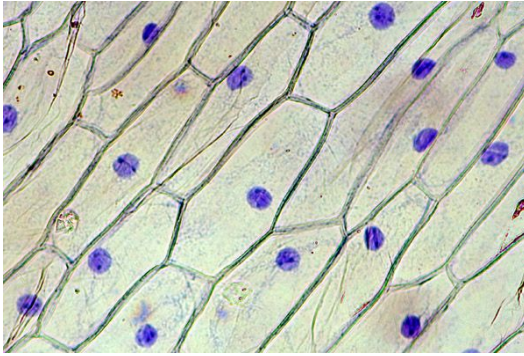


<https://www.instructables.com/Extracting-DNA-from-Strawberries/>





DNA UNDER A MICROSCOPE



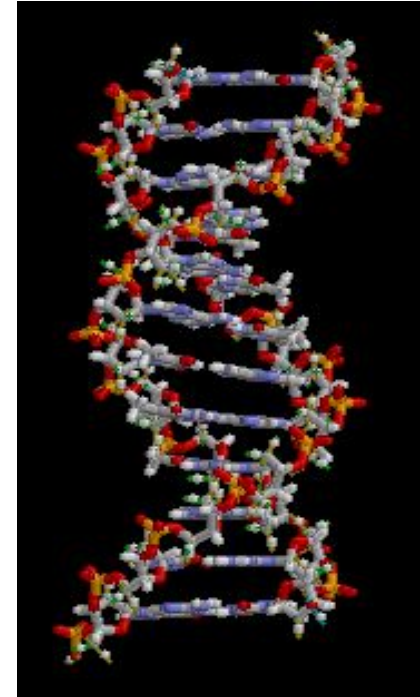
<http://www.microbehunter.com/wp/wp-content/uploads/2009/onion1.jpg>

OR IN A TEST TUBE



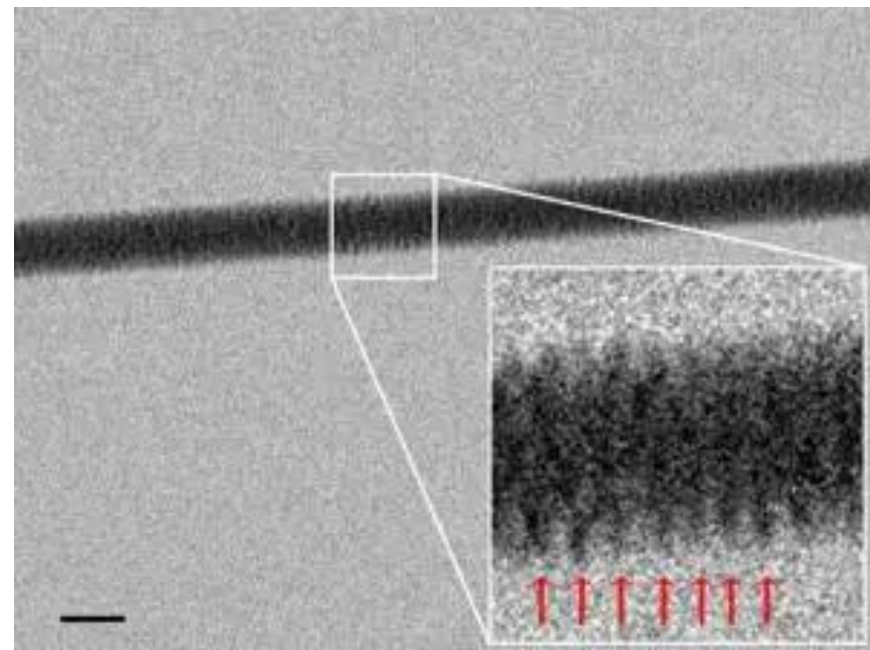
<https://www.instructables.com/Extracting-DNA-from-Strawberries/>

DOESN'T LOOK LIKE THIS!



Direct Imaging of DNA Fibers: The Visage of Double Helix

Francesco Gentile^{†‡}, Manola Moretti[†], Tania Limongi^{†§}, Andrea Falqui[⊥], Giovanni Bertoni^{⊥||}, Alice Scarpellini[⊥], Stefania Santoriello[†], Luca Maragliano[§], Remo Proietti Zaccaria[†], and Enzo di Fabrizio^{†‡*}



<https://pubs.acs.org/doi/10.1021/nl3039162>

<https://www.newscientist.com/article/dn22545-dna-imaged-with-electron-microscope-for-the-first-time/>



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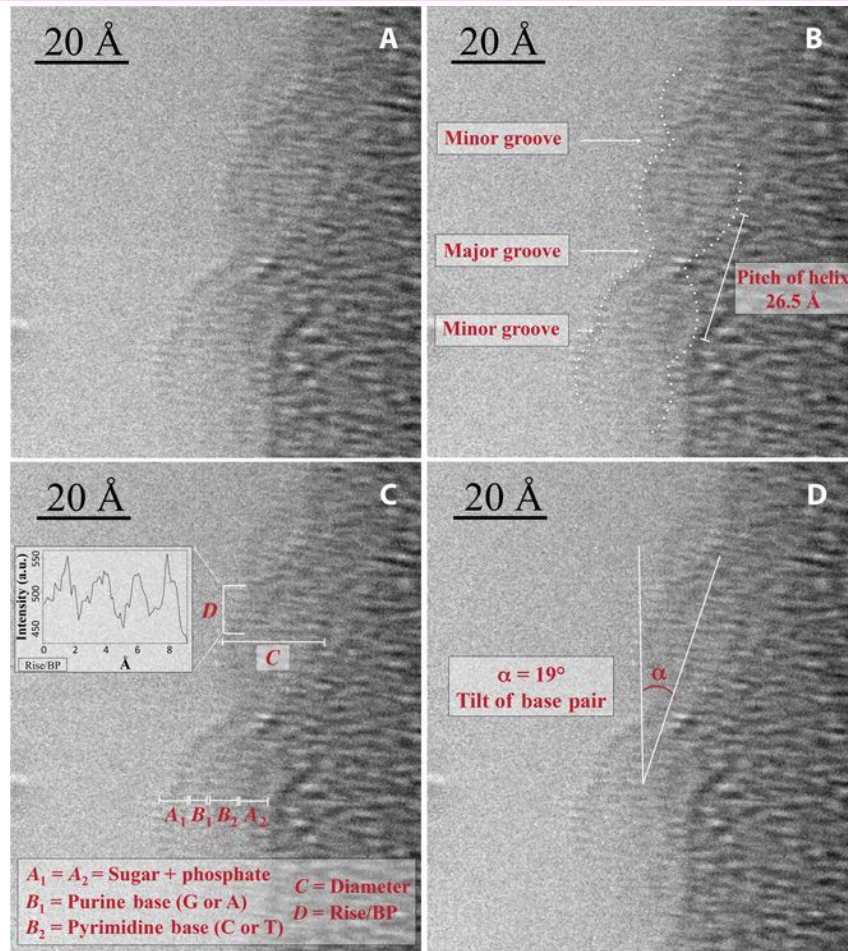
RESEARCH ARTICLE | BIOMATERIALS



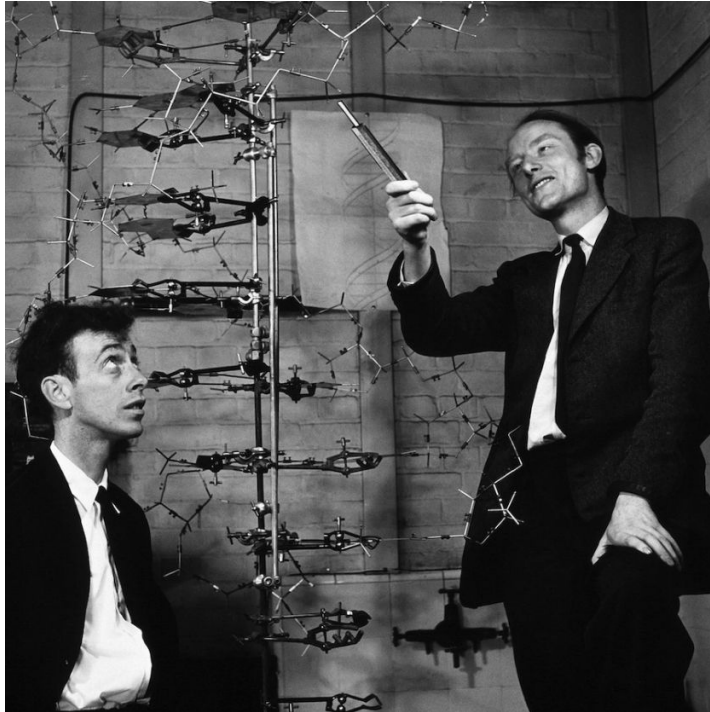
The structure of DNA by direct imaging

MONICA MARINI, ANDREA FALQUI, MANOLA MORETTI, TANIA LIMONGI, MARCO ALLIONE, ALESSANDRO GENOVESE, SERGEI LOPATIN, LUCA TIRINATO, GOBIND DAS

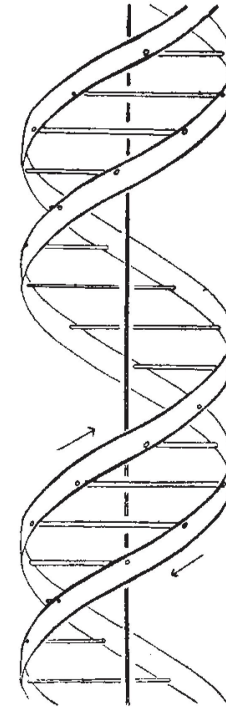
ENZO DI FABRIZIO +5 authors Authors Info & Affiliations



Even Watson and Crick “discovered” the structure of DNA using a model



<https://www.sciencehistory.org/historical-profile/james-watson-francis-crick-maurice-wilkins-and-rosalind-franklin>



<https://www.nature.com/articles/171737a0>



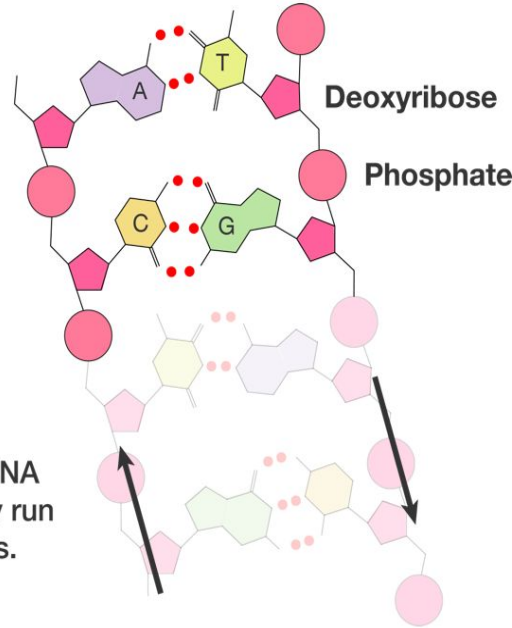
...with a little help from a “friend”



So, whether or not we realize it, we all learned about DNA from models...

Nucleotide bases form hydrogen-bonded pairs in the middle of the double helix, A pairing with T and C with G.

The two strands of DNA are antiparallel—they run in opposite directions.



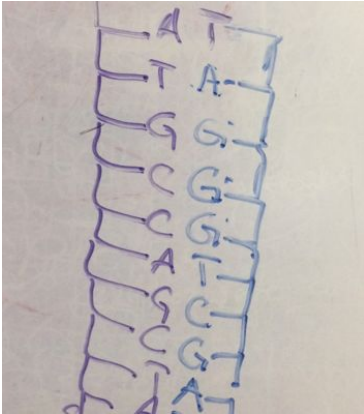
From E.O. Wilson, *Life on Earth*



... and we teach with models



<https://www.instructables.com/The-Double-Helix-Glass-Bead-DNA-model-V20/>



<https://www.instructables.com/DNA-Origami/>

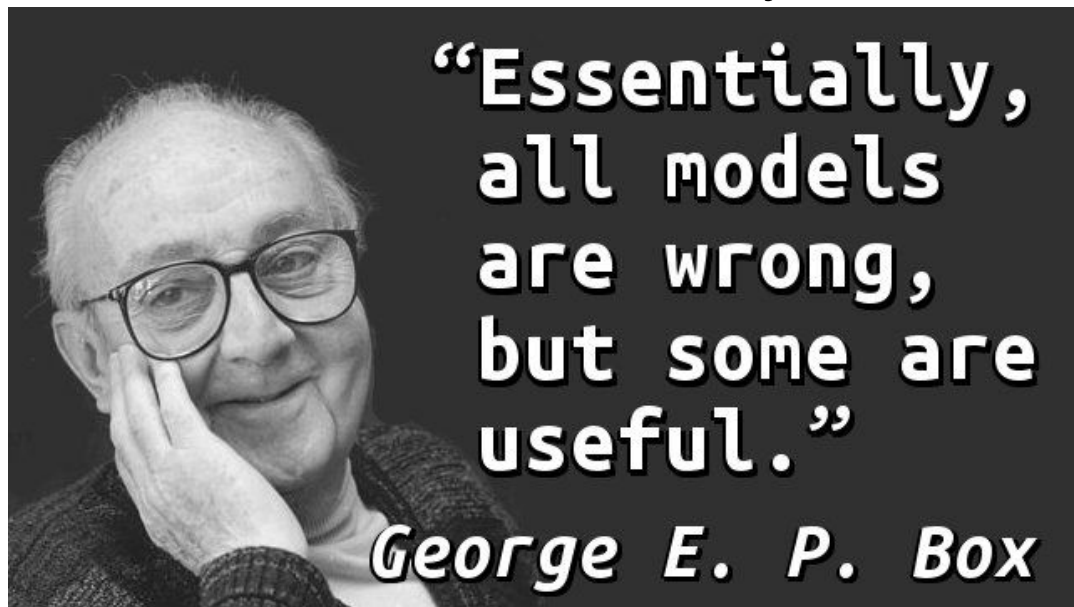


<https://www.sciencebuddies.org/stem-activities/candy-DNA-model>



We must be aware of the limitations of the models...

- And this conceptions they create...
- And the essential information that they include... or exclude...



What do our students NEED to know about the structure of DNA, and why?



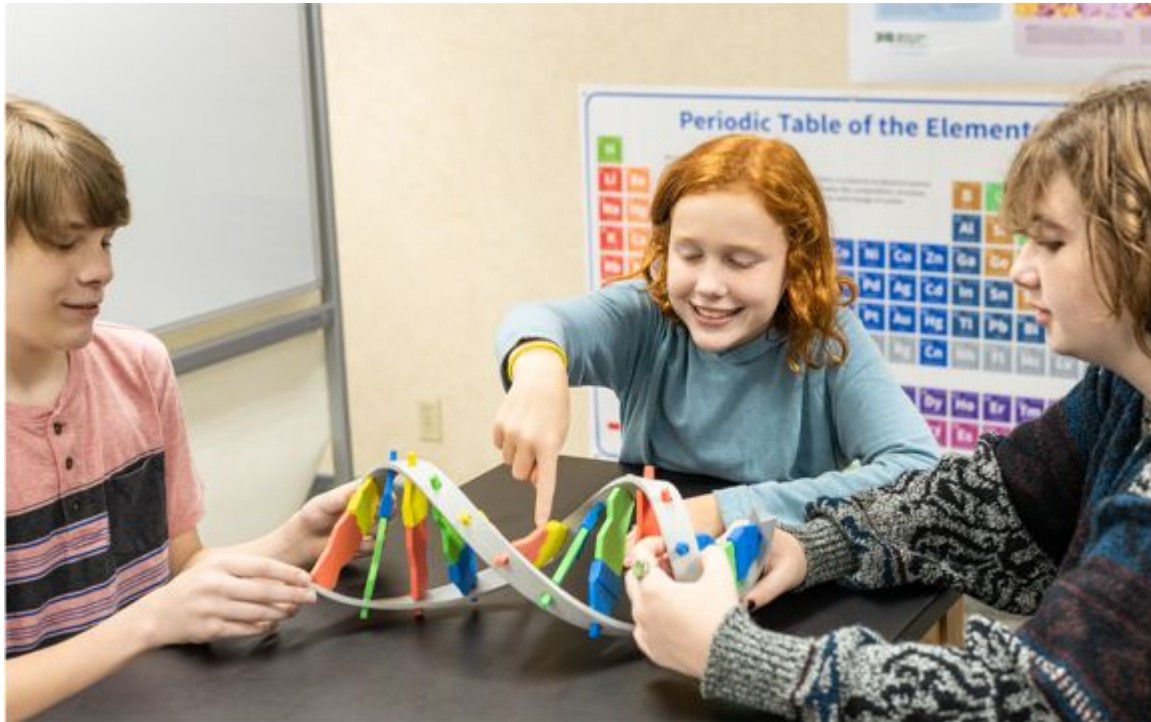
ATTENDEE RESPONSES:

Beta Thalassemia- DNA in the nucleus, gene, premarriage gene test, allows student so know how to manage their lives.

GCAT

MRNA vaccines- effect on DNA?

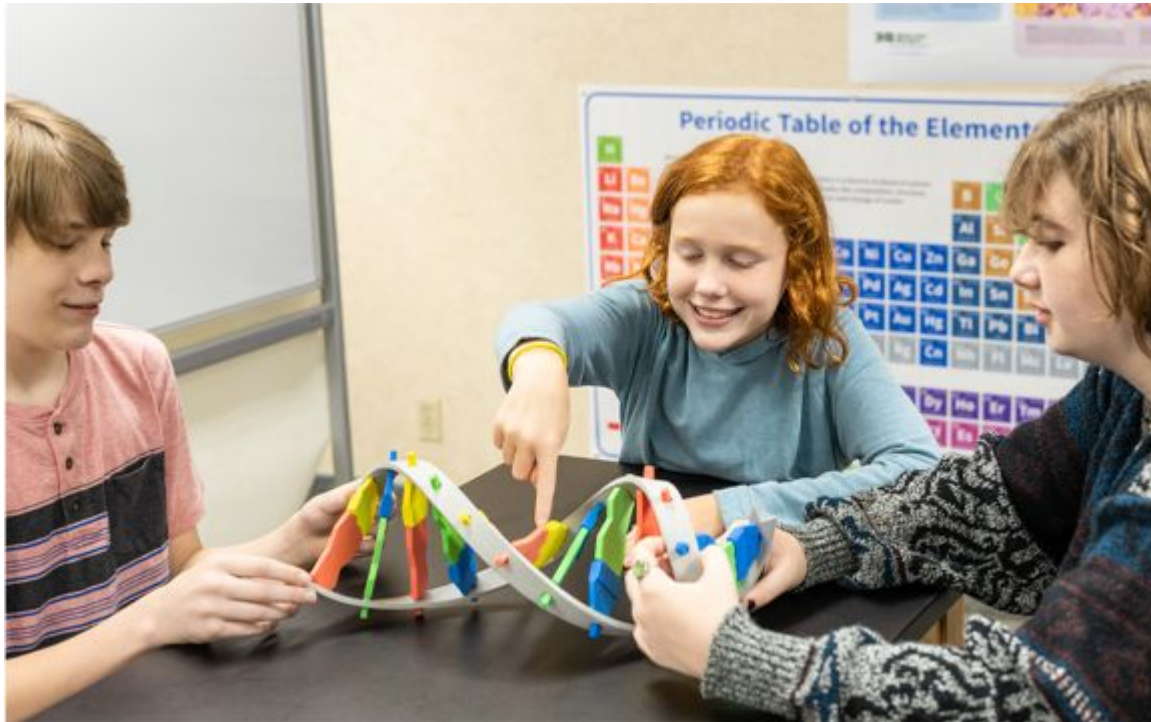
Let's get our hands busy!



“Based on
this model, I
see that
DNA...”



Let's get our hands busy!



“Based on
this model, I
wonder...”



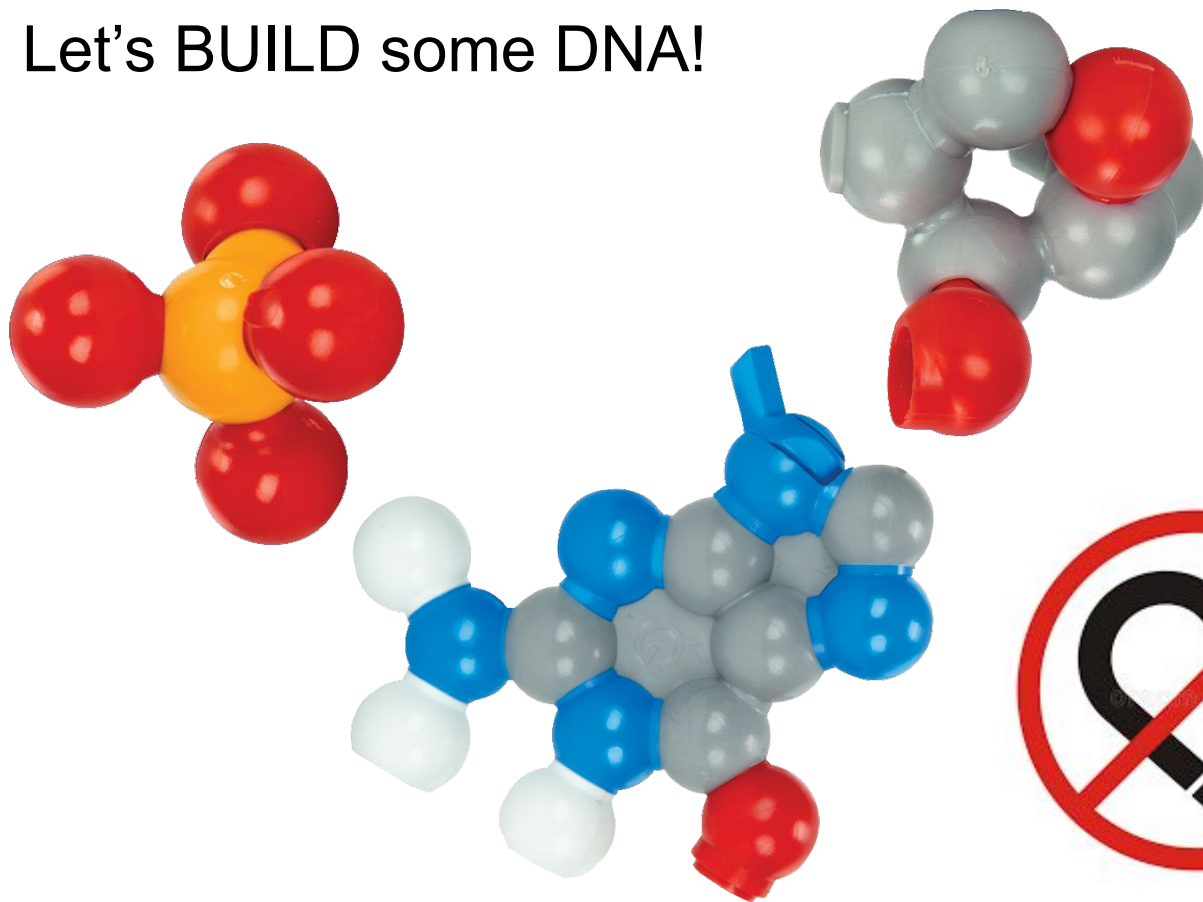
What learning targets have we hit with student interactions with just this model?



What are some limitations of this model (and why to they matter?)



Let's BUILD some DNA!

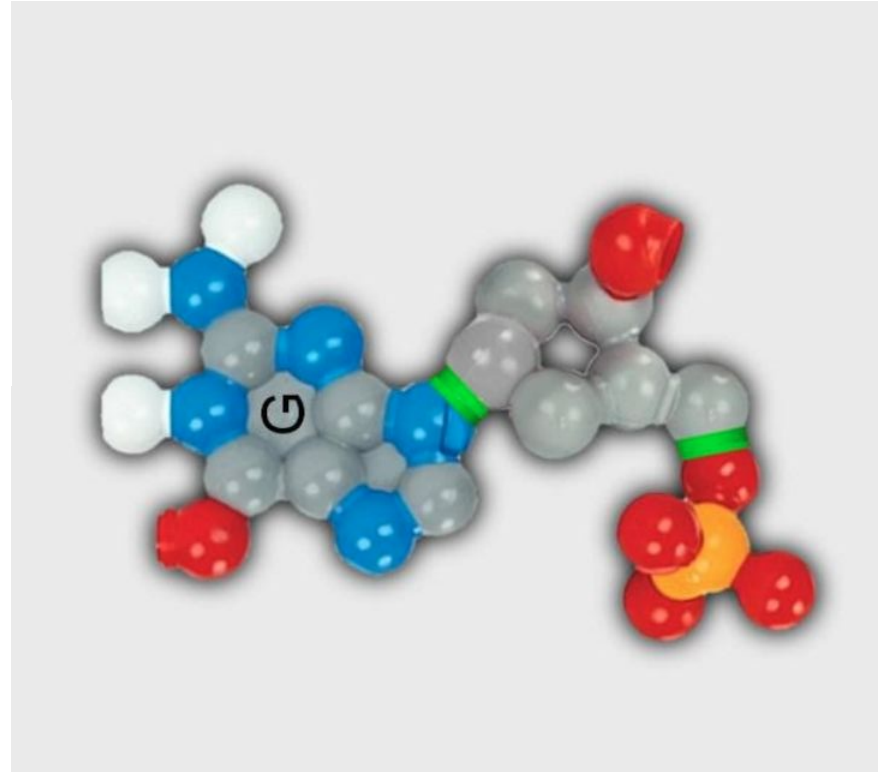




What you have now is a... nucleotide!

CPK Color Scheme used by RasMol and Chime

C	H	O	N	S	P	Na	Mg	Ca	Zn	Cl	F	I	Li	He	
					Fe Ba			Mn Cr Al Ti Ag	Cu Ni Br	B	Si Ag				all else
↑	↑	↑	↑		↑										



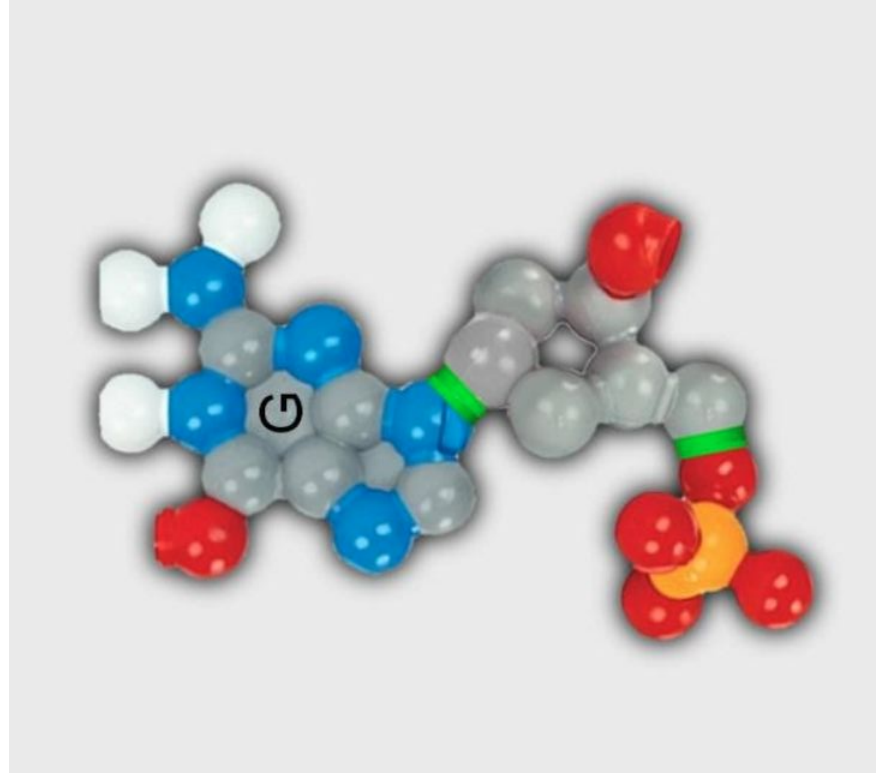


What you have now is a... nucleotide!



LookAround

Is yours the same as
your neighbors?





Remember A pairs with T and G pairs with C?



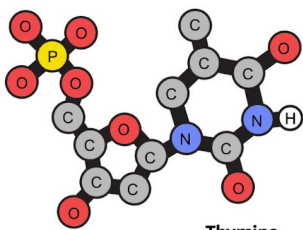


Find your partner / pair!

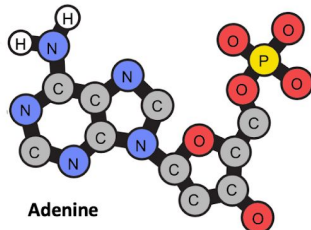
And this time... use your magnets!

Nucleotide Base Pairs

3-D Molecular Designs
...where molecules become real™



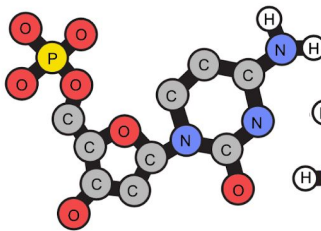
Thymine



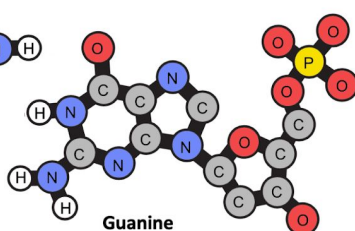
Adenine

Atom Color Key:

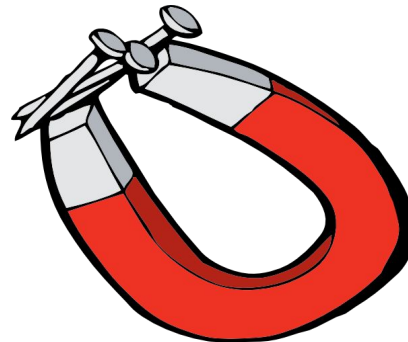
- (H) Hydrogen
- (N) Nitrogen
- (C) Carbon
- (O) Oxygen
- (P) Phosphorus



Cytosine

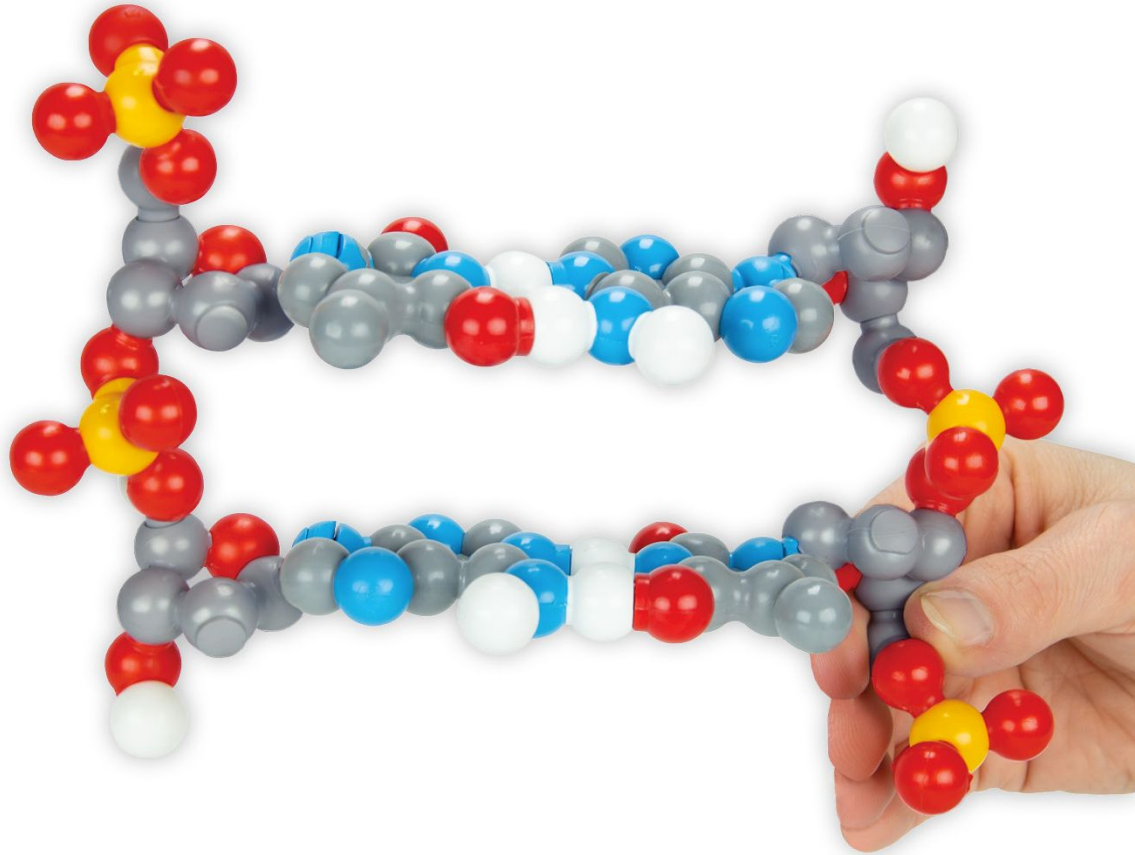


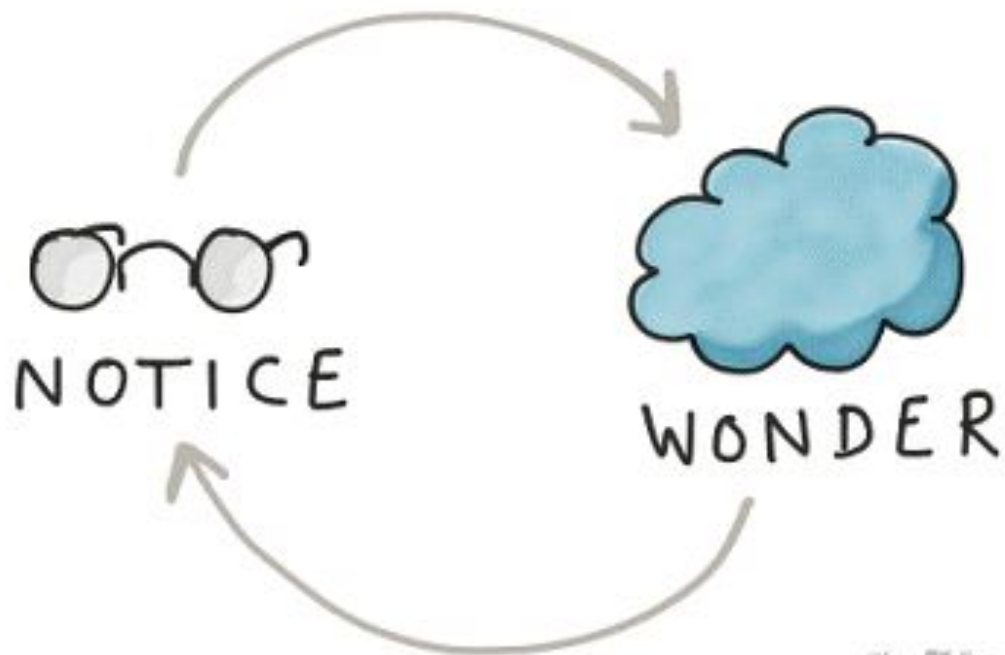
Guanine





Find another pair... and put yours together!



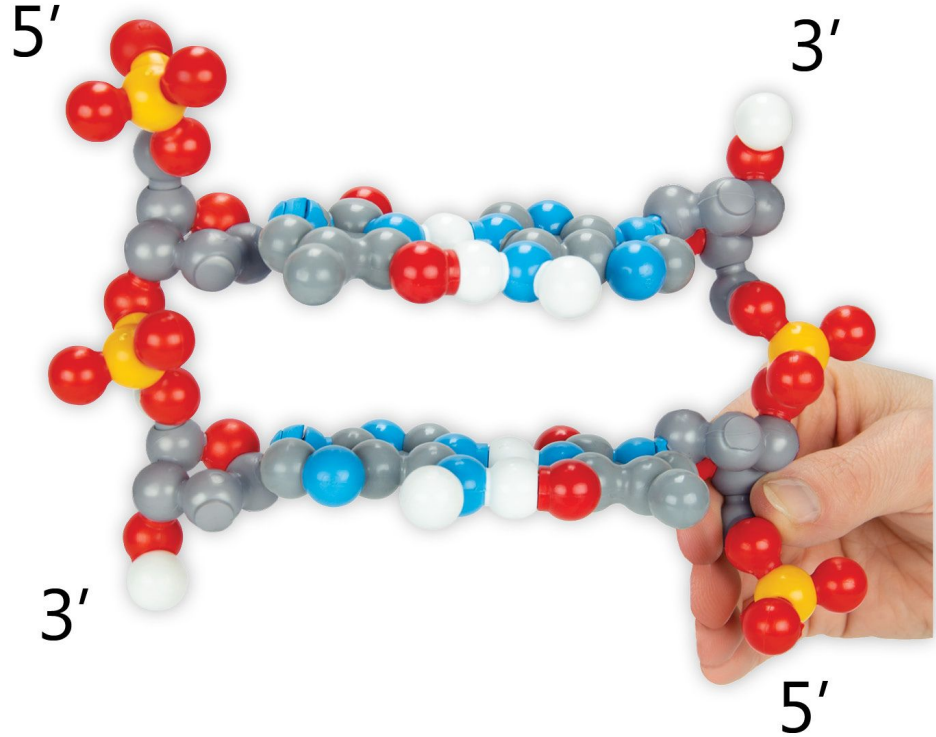
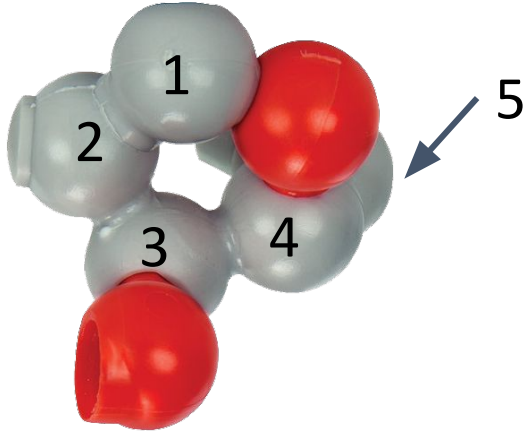


©BrainiacWorks



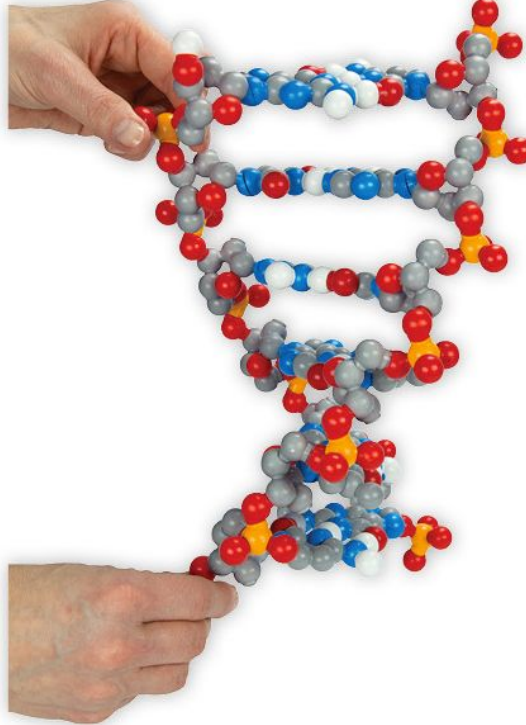


DNA is Antiparallel





DNA is Flexible



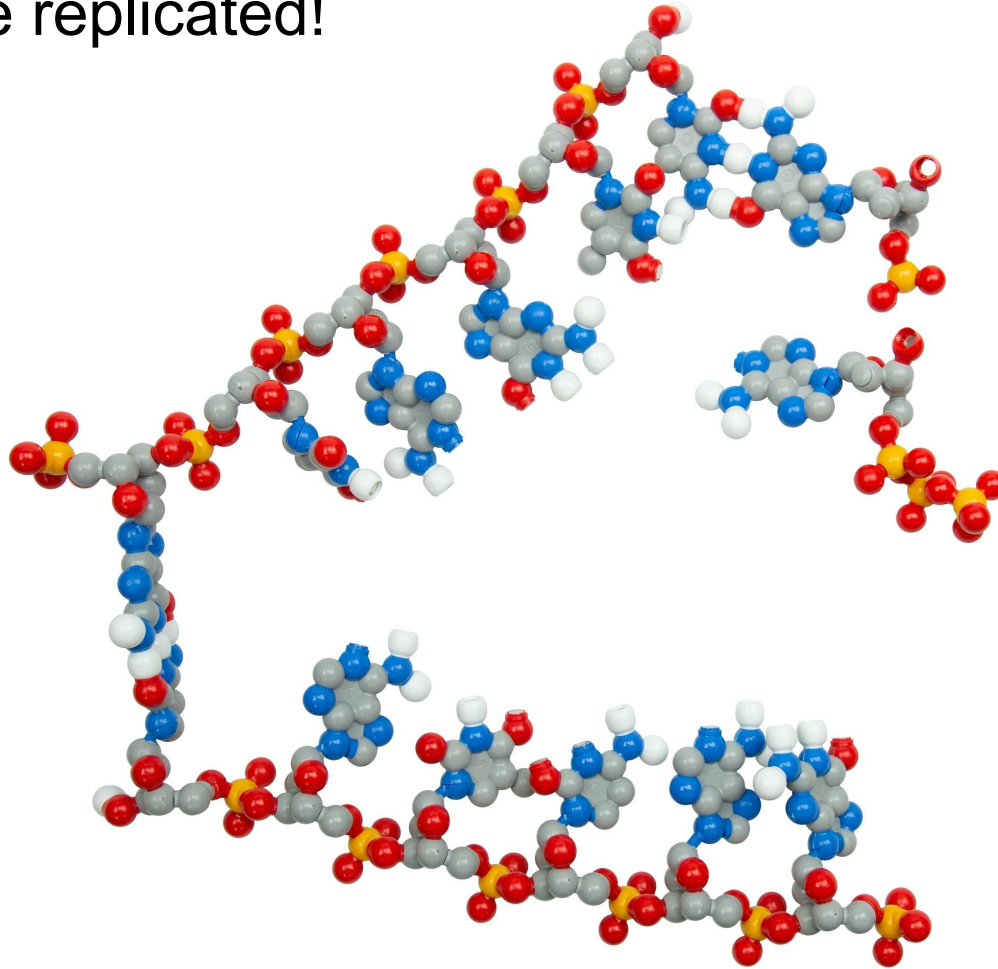


DNA has a major groove... and a minor groove



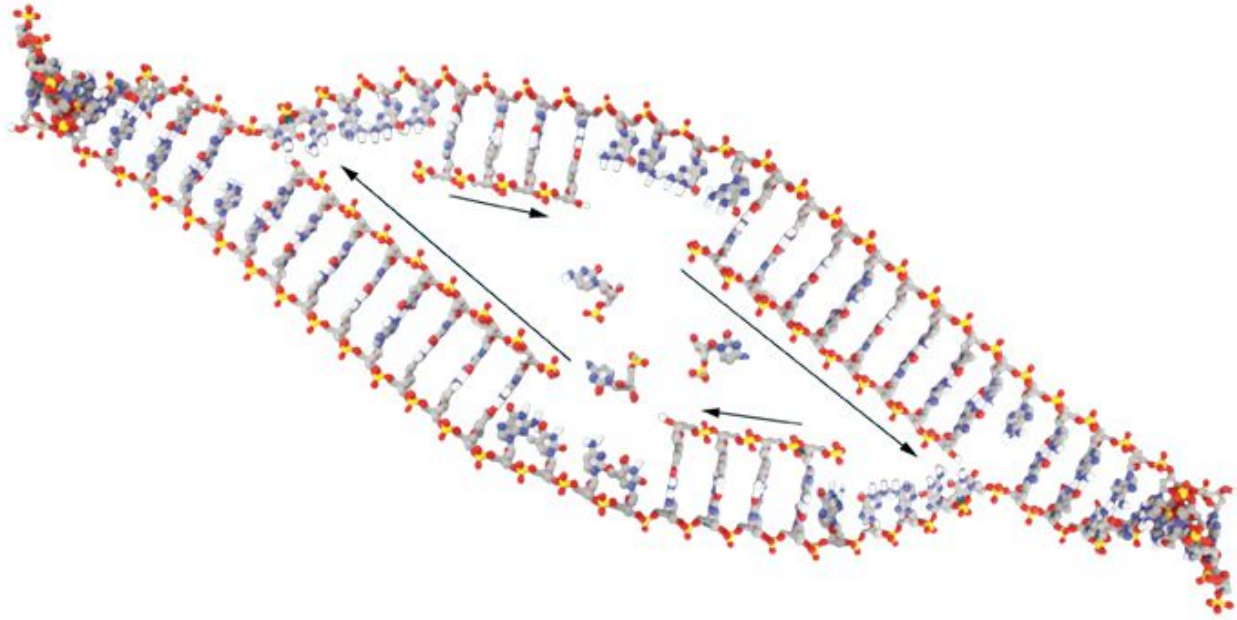


DNA can be replicated!





DNA can be replicated!





Wait, this isn't just DNA!

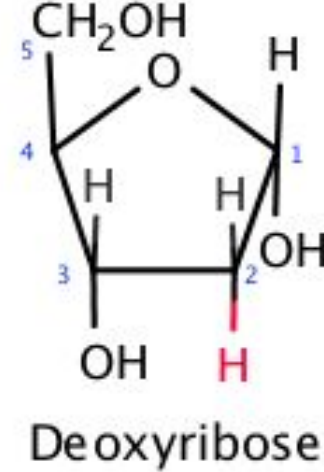
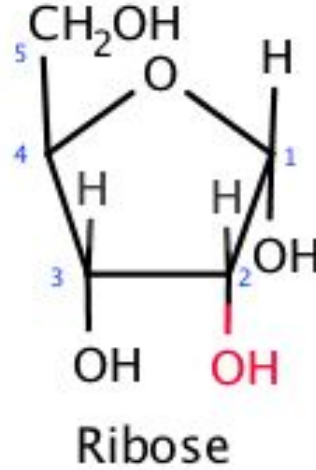
How does DNA differ
from RNA?





Wait, this isn't just DNA!

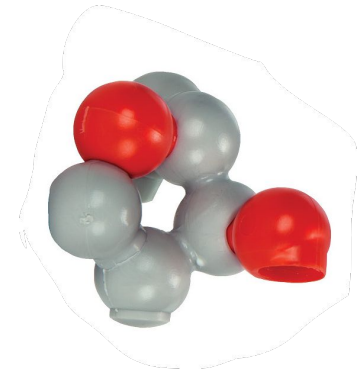
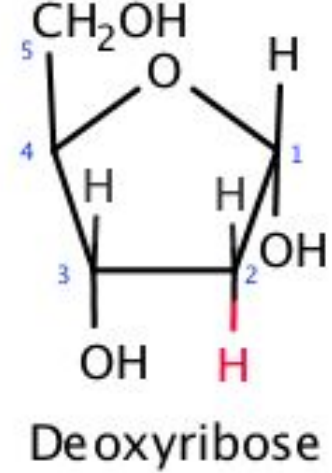
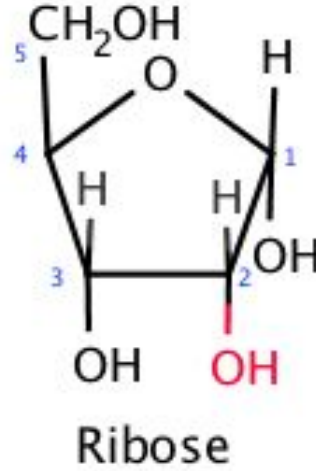
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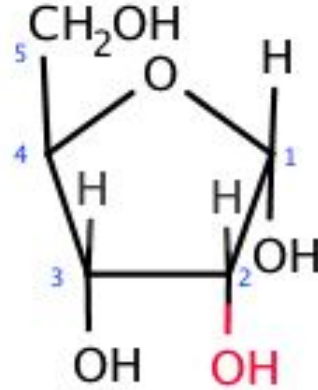
How does DNA differ
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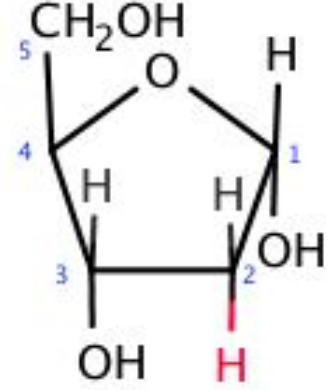


Wait, this isn't just DNA!

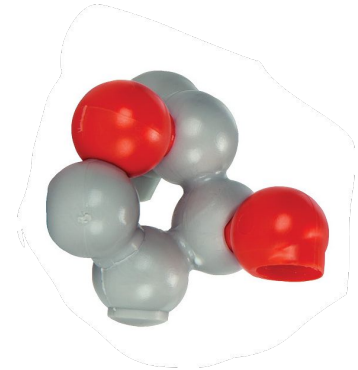
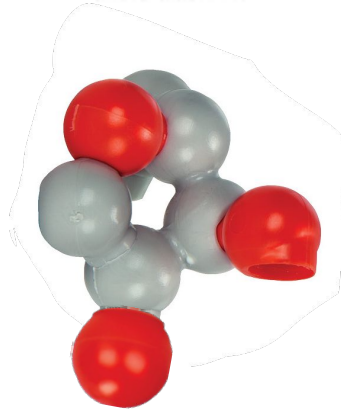
How does DNA differ
from RNA?



Ribose



Deoxyribose





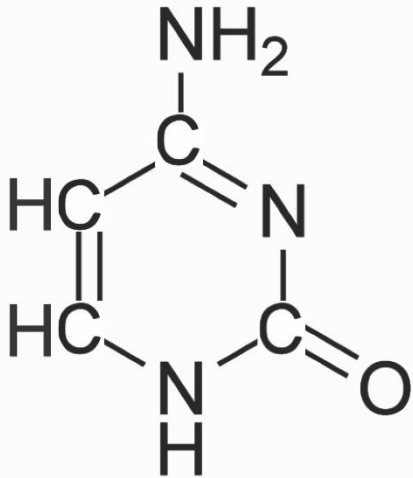
But why U?



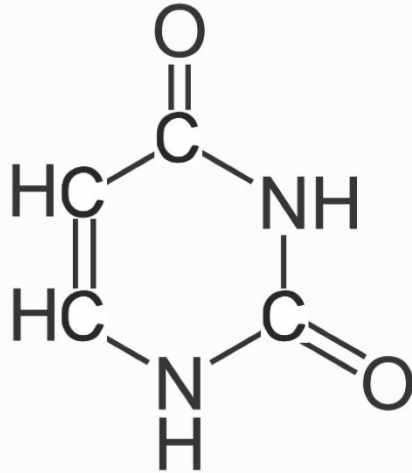


But why U?

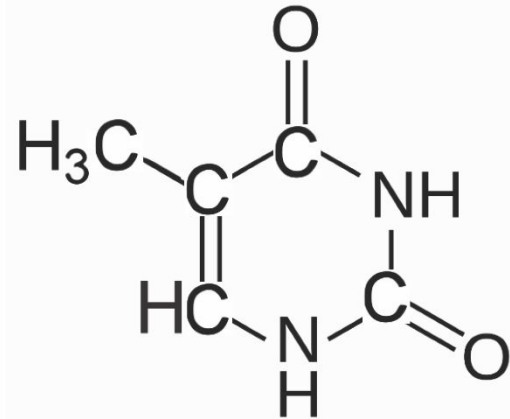
The Pyrimidines: cytosine, uracil, and thymine



Cytosine



Uracil

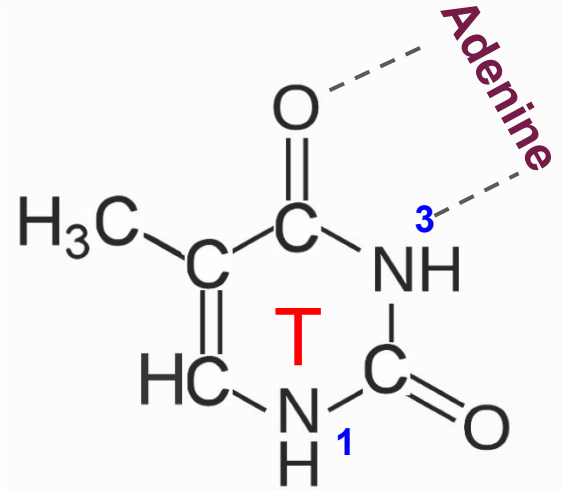
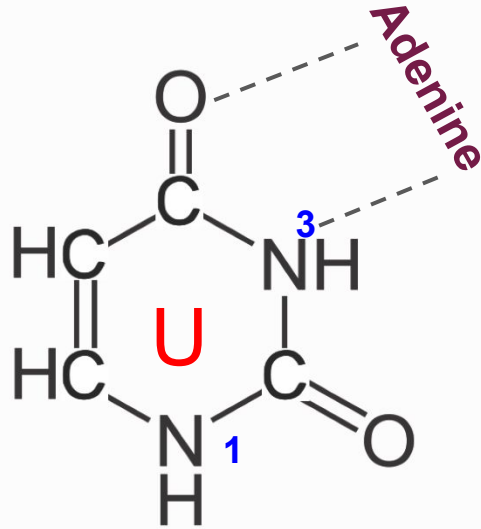
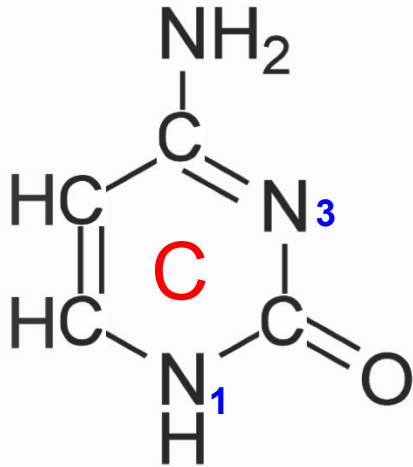


Thymine



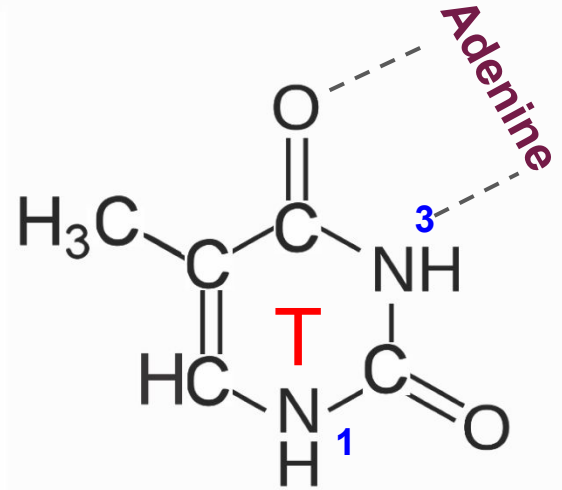
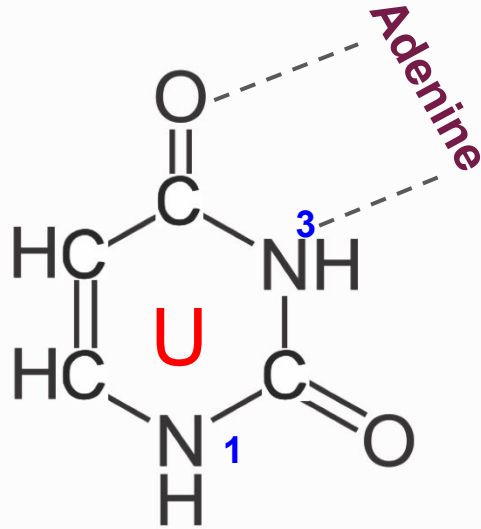
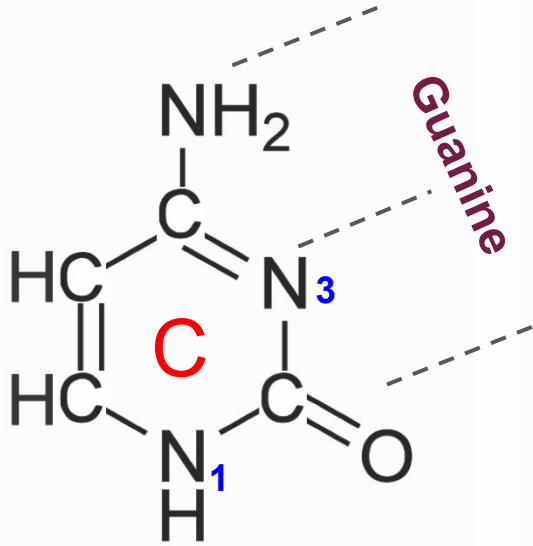


But why U?





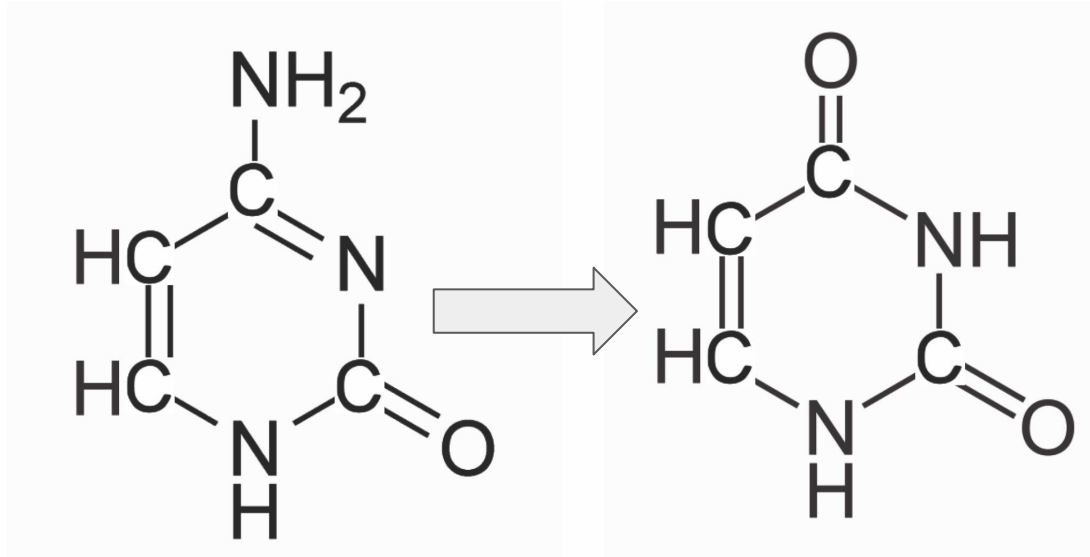
But why U?





But Why U?

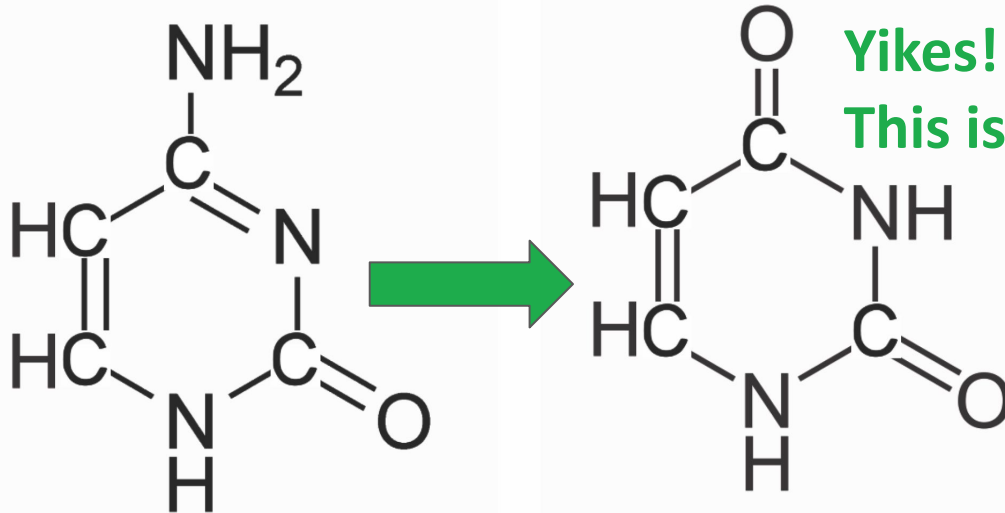
In every cell, every day, 100-500 times a day, cytosine will spontaneously undergo oxidative deamination.





But Why U?

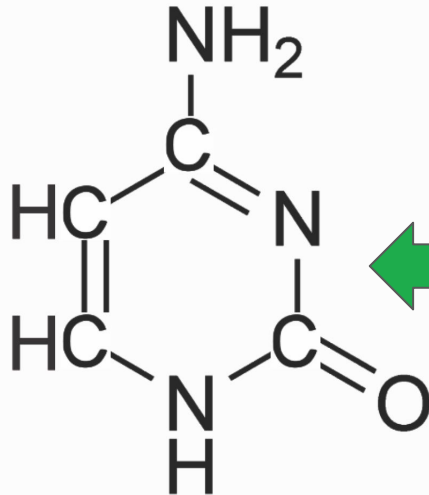
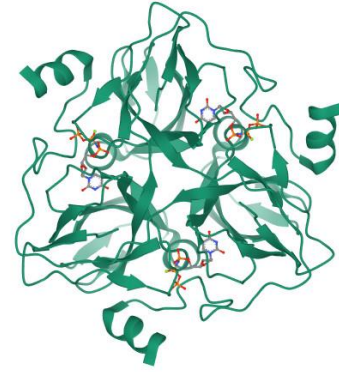
In every cell, every day, 100-500 times a day, cytosine will spontaneously undergo oxidative deamination.



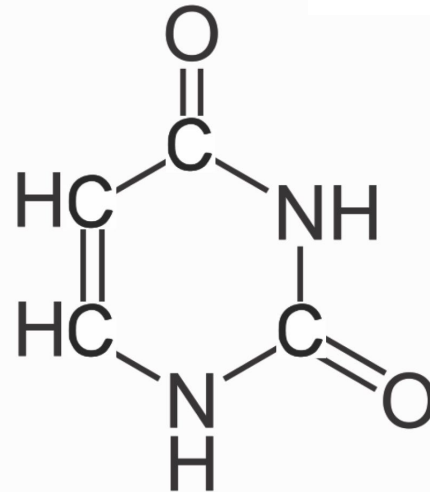


But Why U?

dUTPase to the rescue!



Cytosine

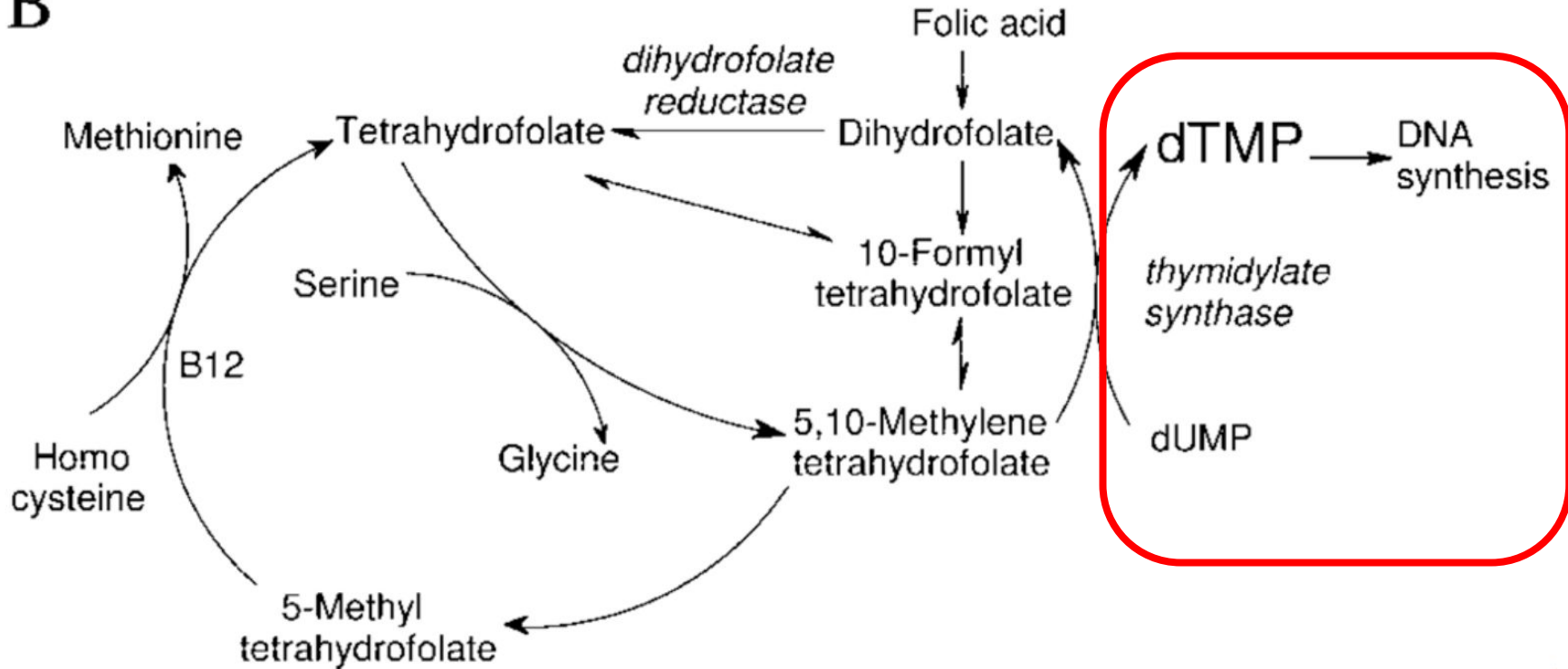


Uracil



Thymine biosynthesis converts U to T!

B





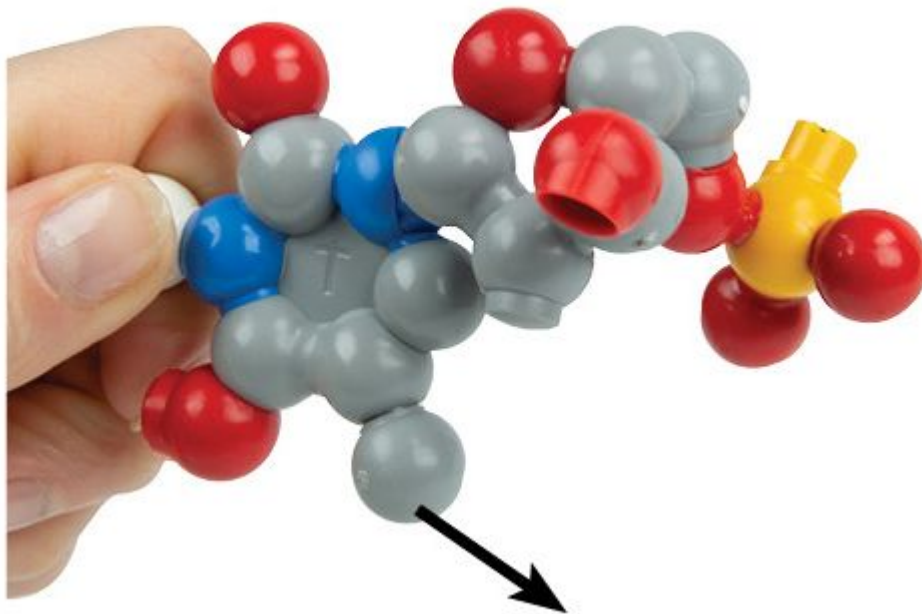
So the real question is...

Why Thymine?



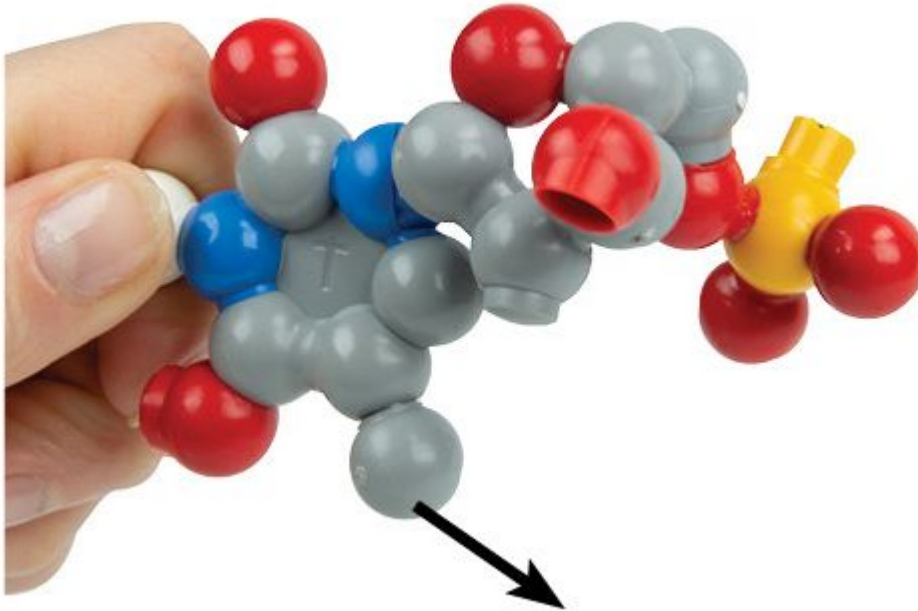


What about U?





What about U?



Remove a methyl from T!!!





What about U?

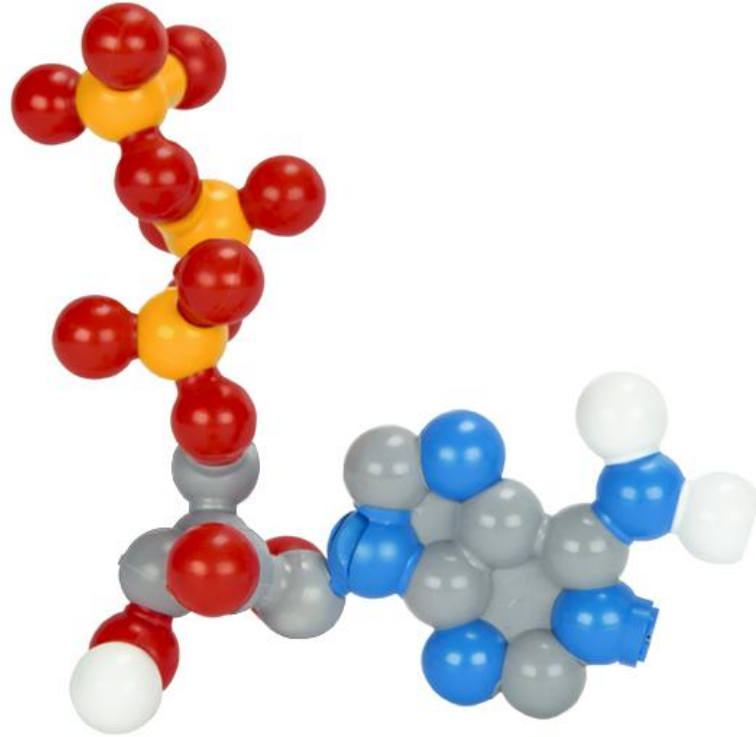


Remove a methyl from T!!!

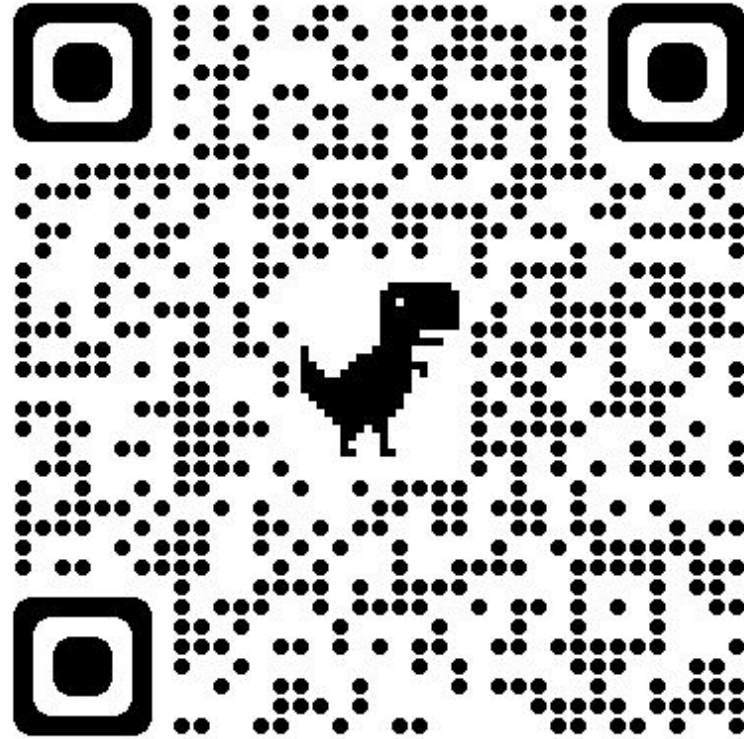


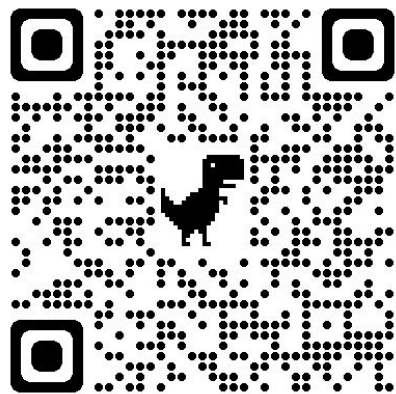


ONE MORE THING!! WHAT IS THIS?



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