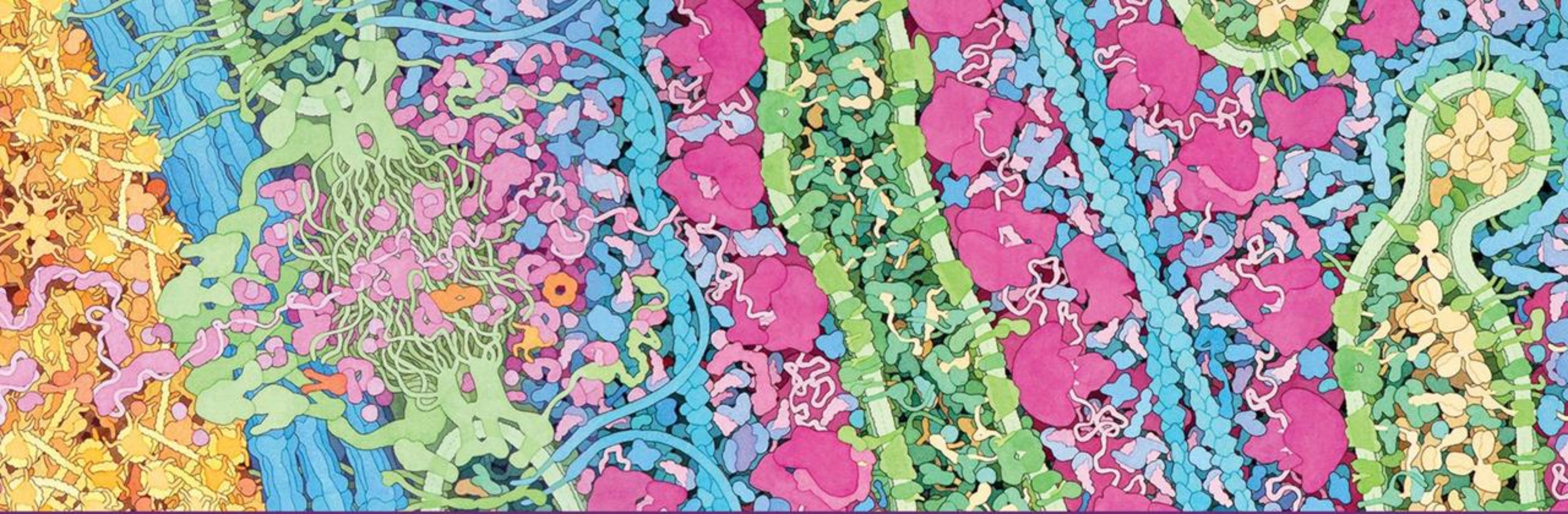


3d molecular designs

Transforming Science Learning

Making Sense of Genetic Information Through Modeling: Replication, Transcription, Translation

Presenter: Chris Chou

Longmont High School (Longmont, CO)

Mrs.Chou@gmail.com

Workshop Learning Goals

- Model the processes of replication, transcription, and translation
- Compare the function of DNA and RNA
- Explain how polypeptides (proteins) are formed

Which grades/subjects do you teach?

Why Models?

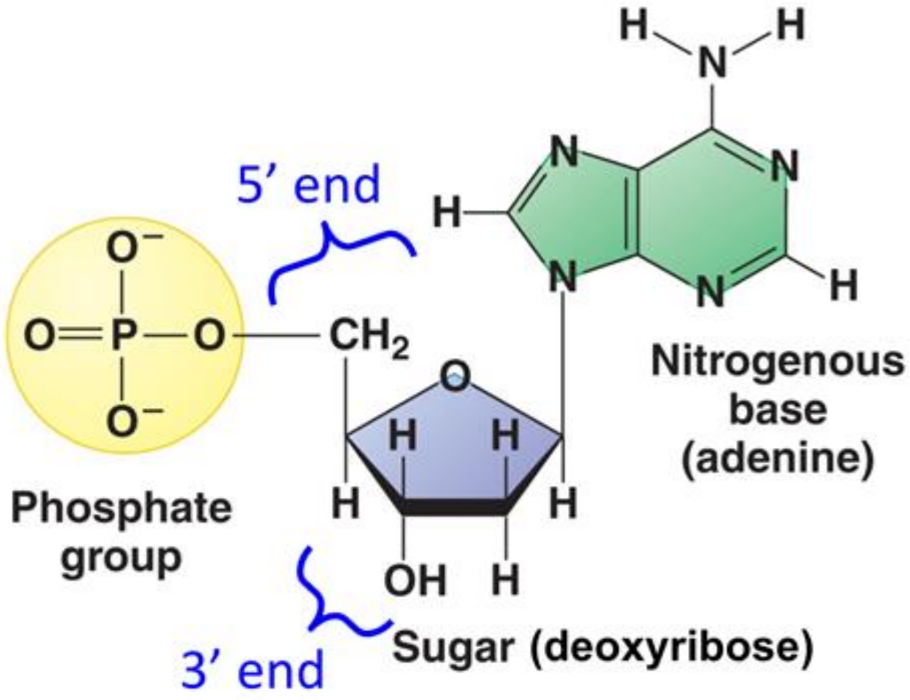
Flow Of Genetic Information Kit©

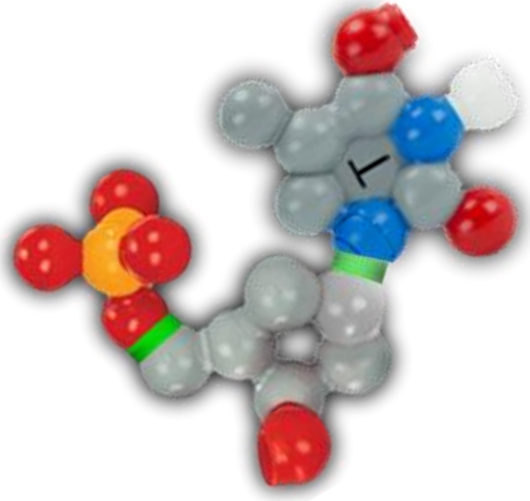
Prerequisite Knowledge and Skills

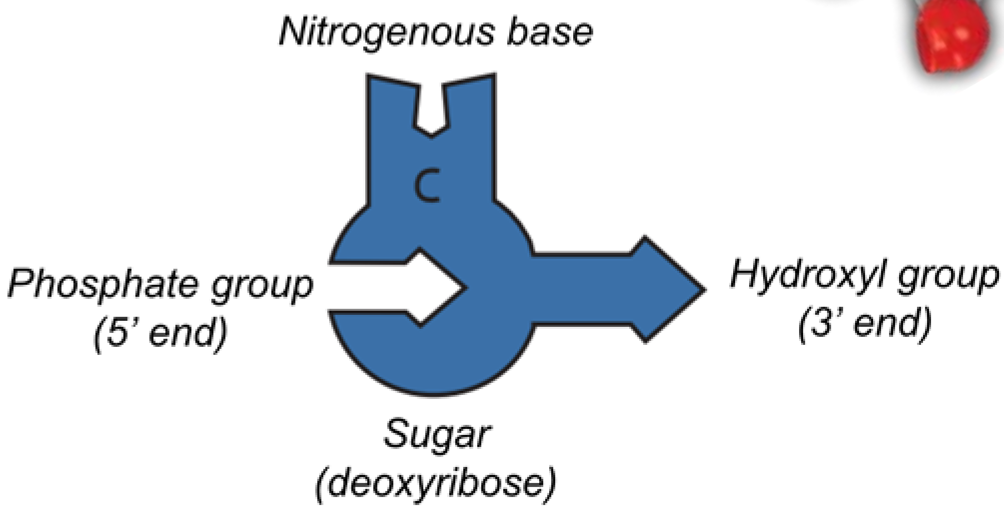
(For this activity)

- Hydrogen bonding and covalent bonding
- Cell structure
- Prokaryotic and eukaryotic cells
- Basic DNA structure
- Cell cycle basics

These are different representations of DNA nucleotides.

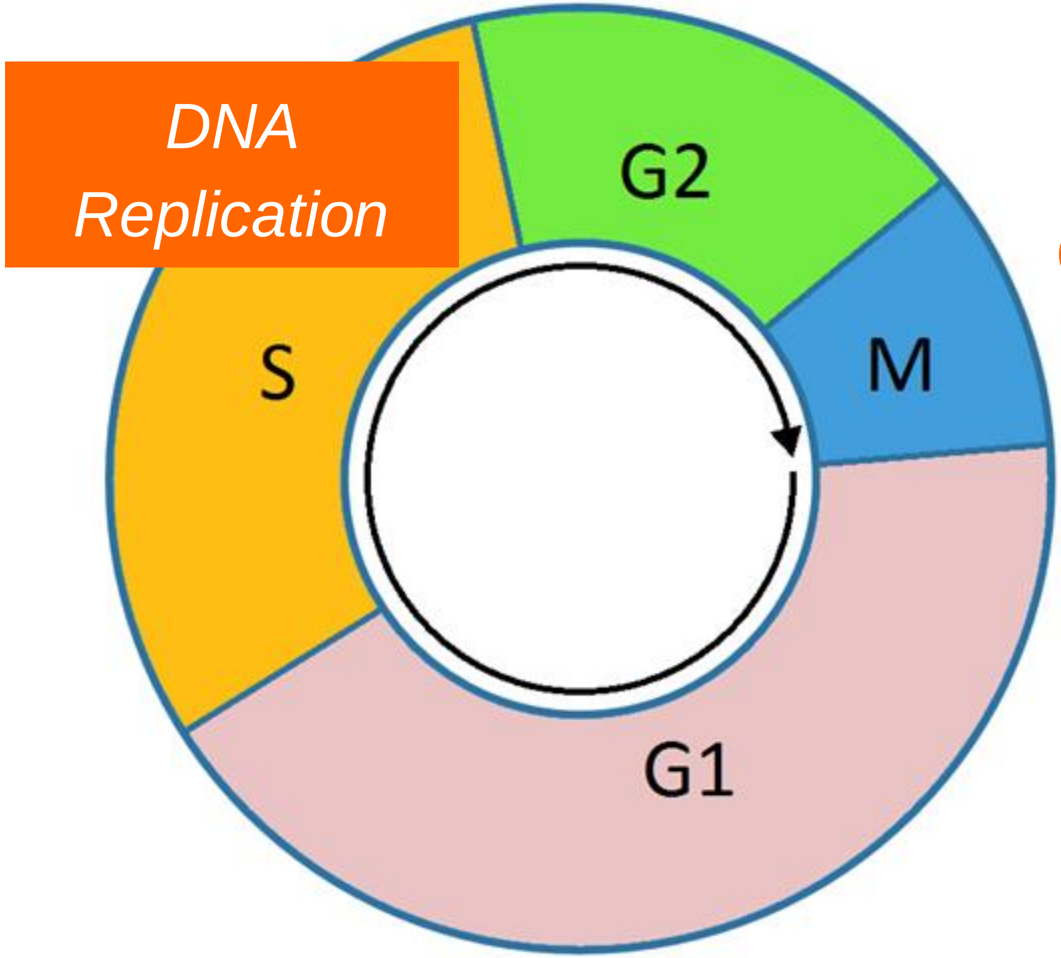






What do you notice? What do you wonder?

The Cell Cycle



G1 - Growth

S - DNA synthesis

REPLICATION

G2 - Growth and preparation for mitosis

M - Mitosis (cell division)

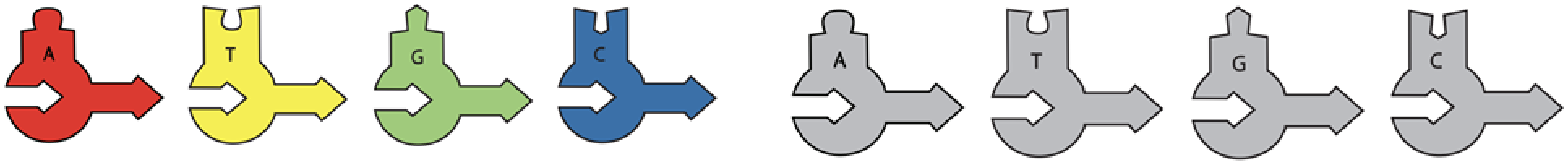
Transcription

Translation

Replication

Materials Needed:

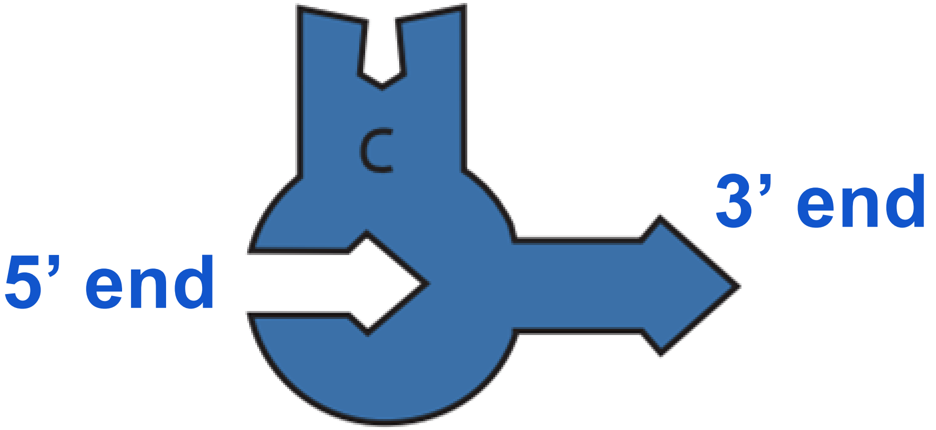
- DNA Replication Placemat (Helicase)
- 2 DNA polymerases
- Foam DNA nucleotides (colored and grey)



Replication Tips:

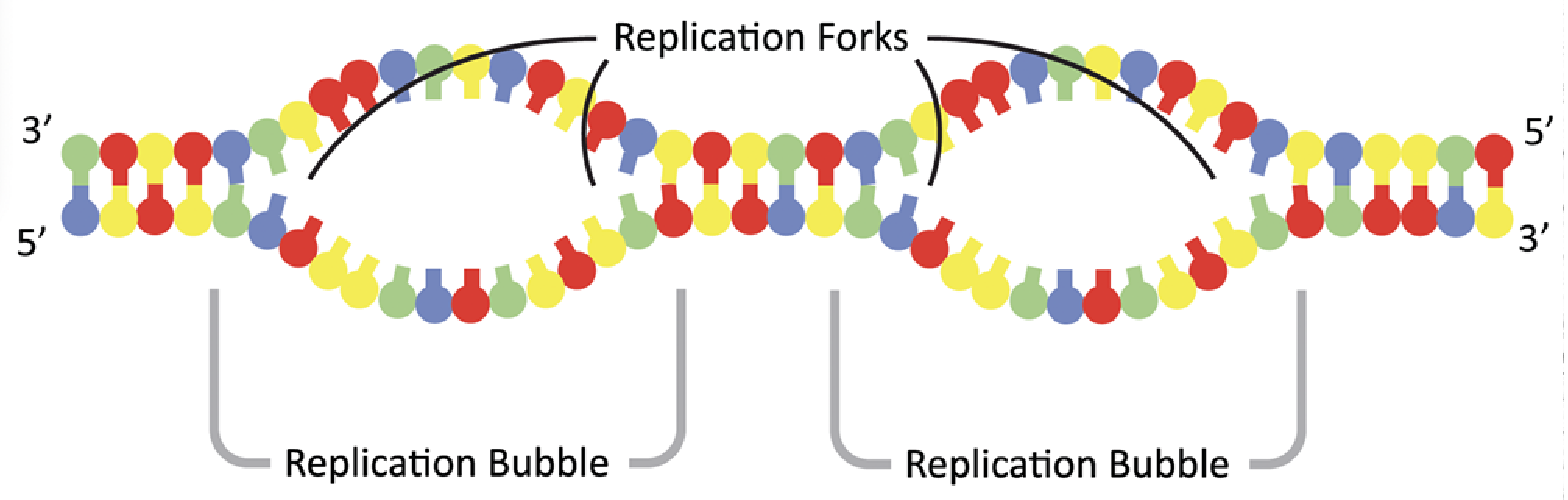
Colored = parent DNA strands

Grey = daughter DNA strands



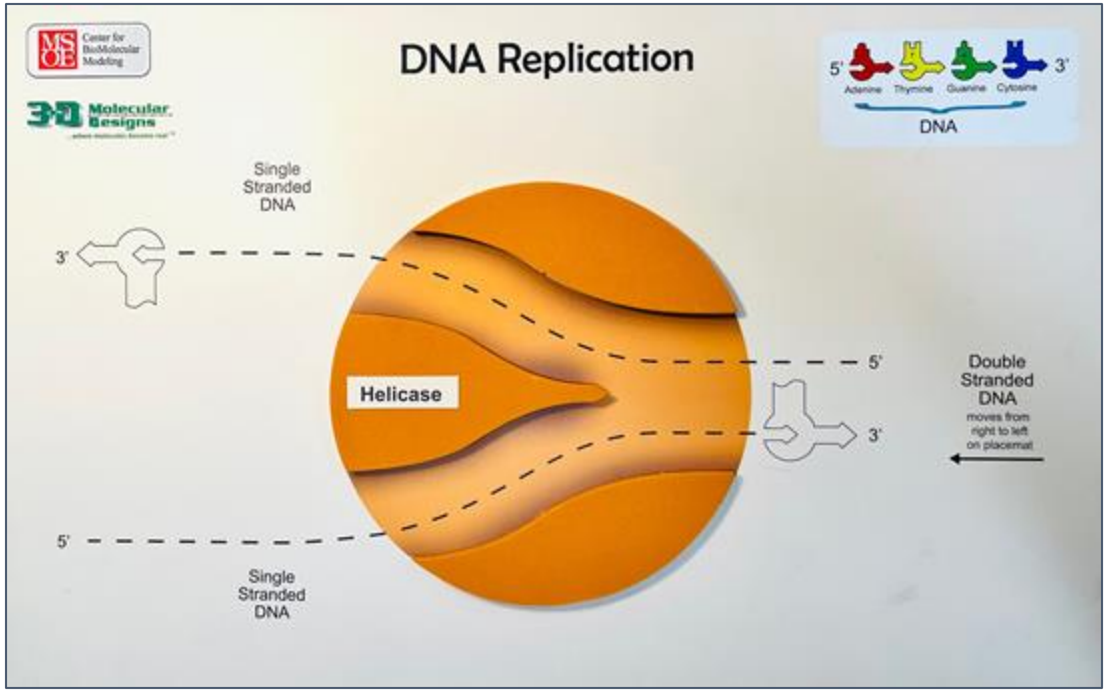
Note: New nucleotides are added to the 3' end of a growing DNA strand by **DNA polymerase**

Origins of Replication

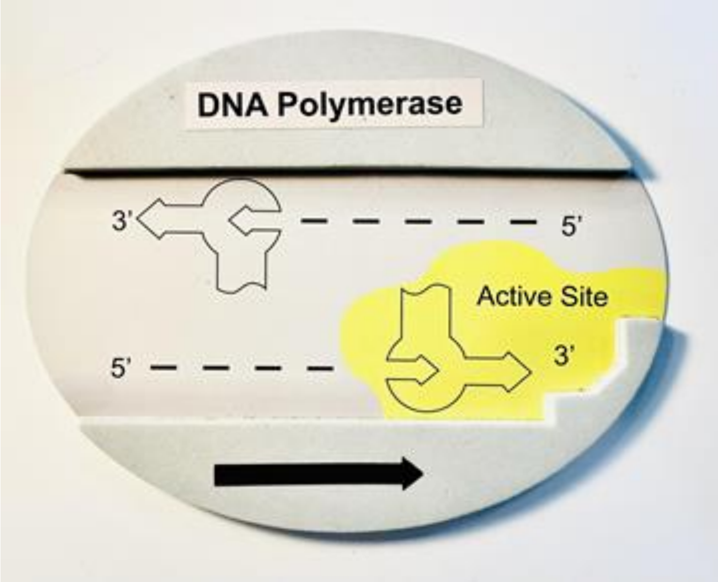


Replication Enzymes

HELICASE



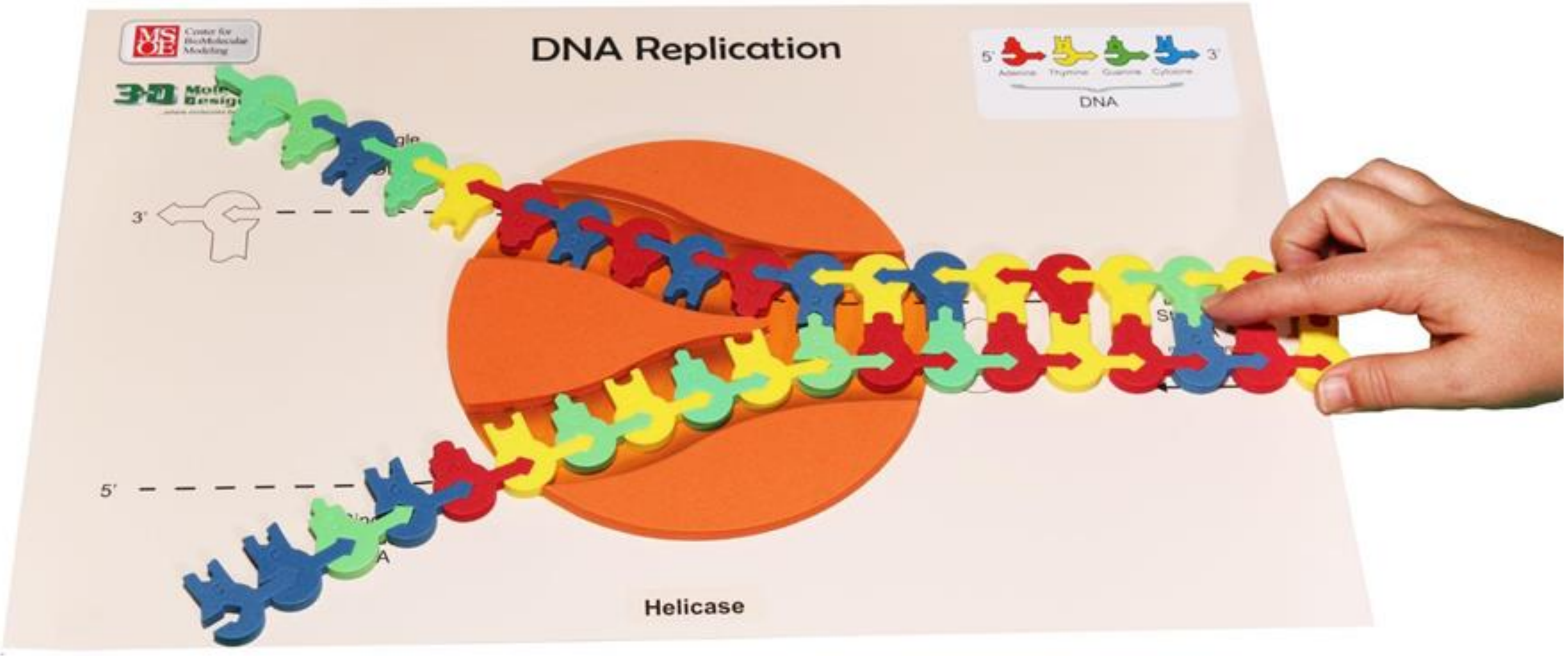
DNA POLYMERASE



What do you notice? What do you wonder?

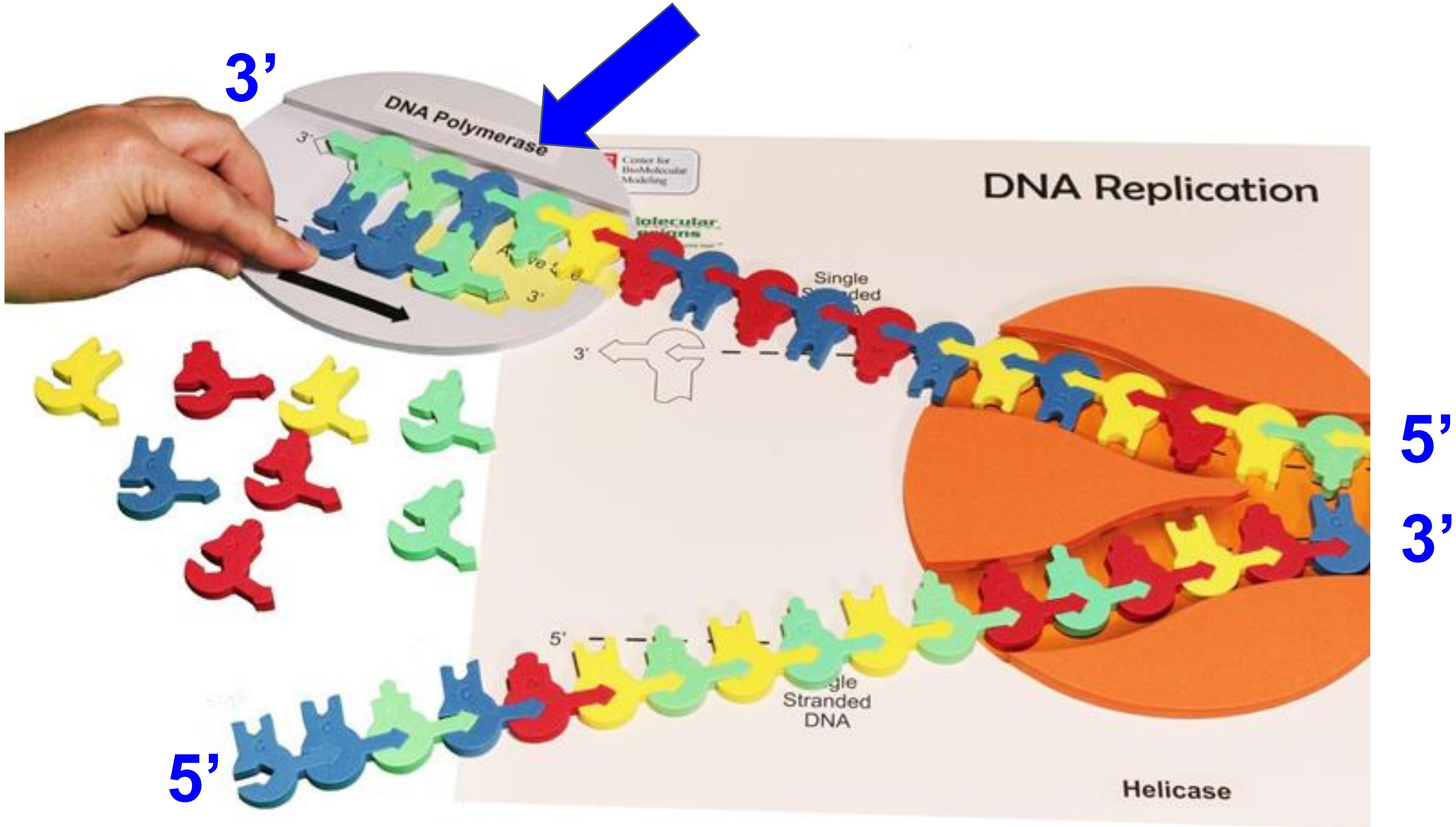
Model the Process of Replication

- ***HELICASE*** unwinds and “unzips” DNA at a replication fork

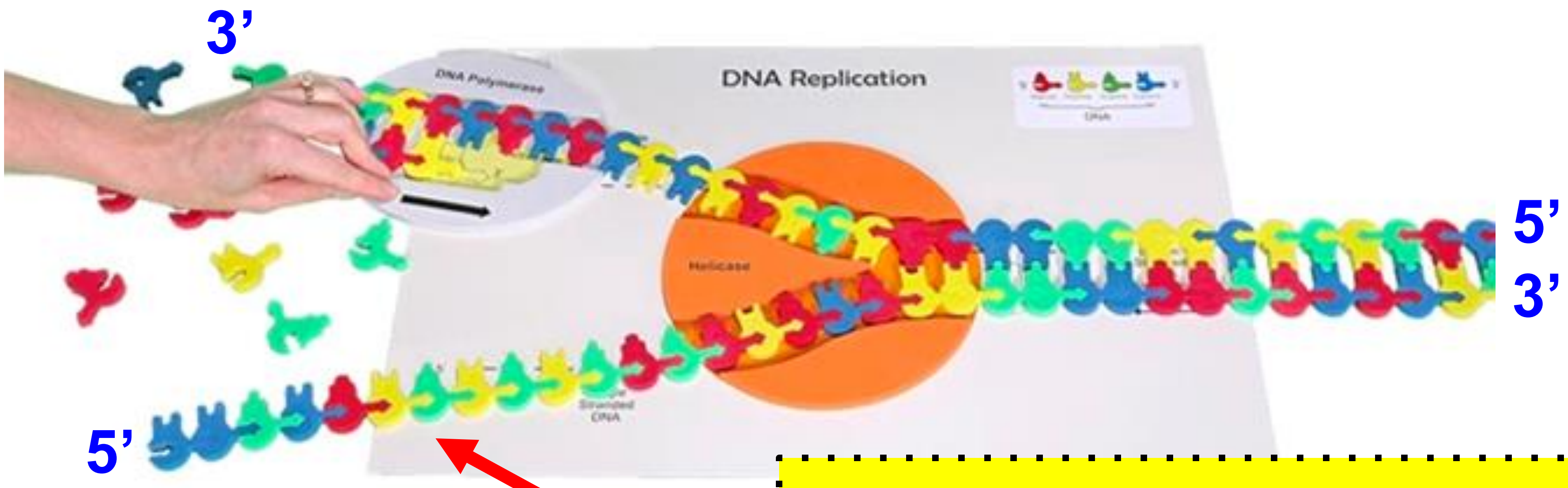


Model the Process of Replication

- ***DNA POLYMERASE*** synthesizes a complementary strand of DNA, which is elongated in the $5' \rightarrow 3'$ direction



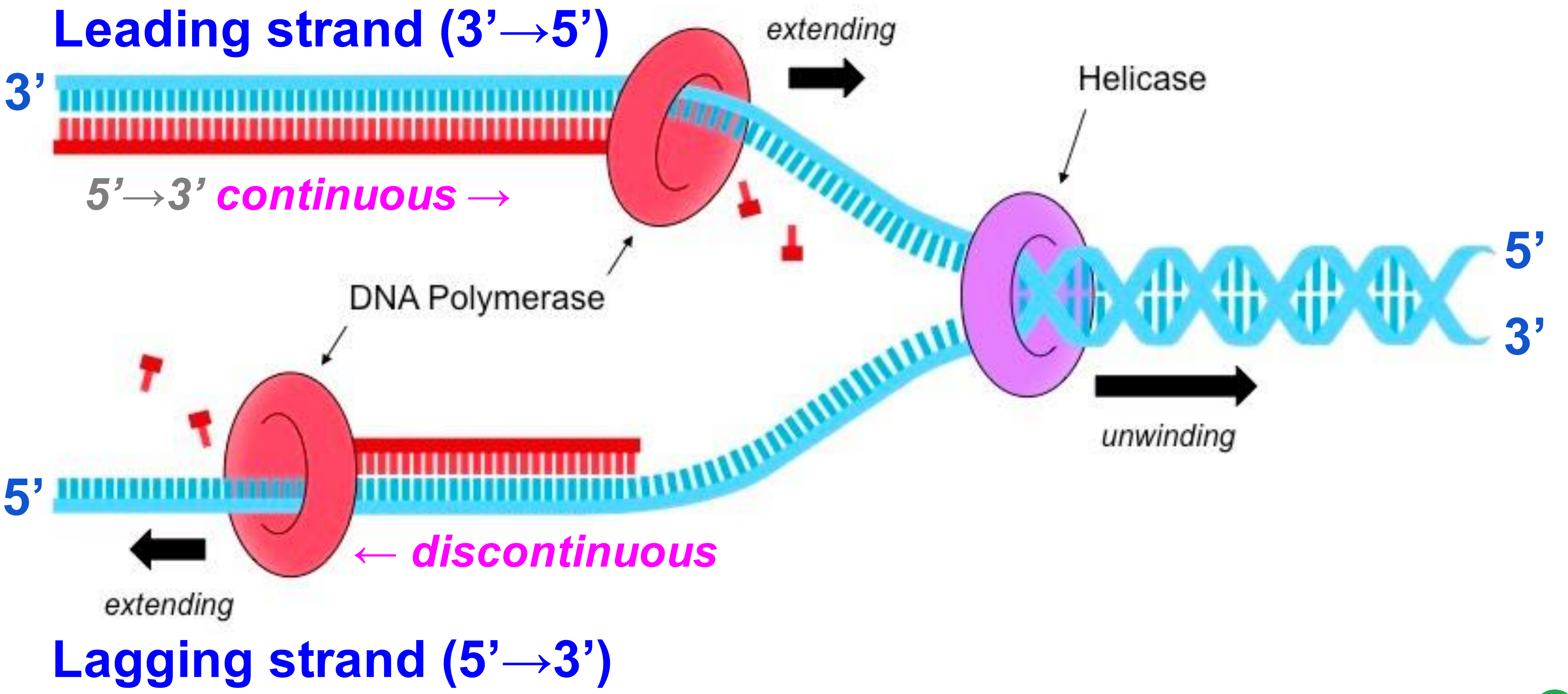
How will DNA be synthesized on the **opposite strand** of DNA?



?

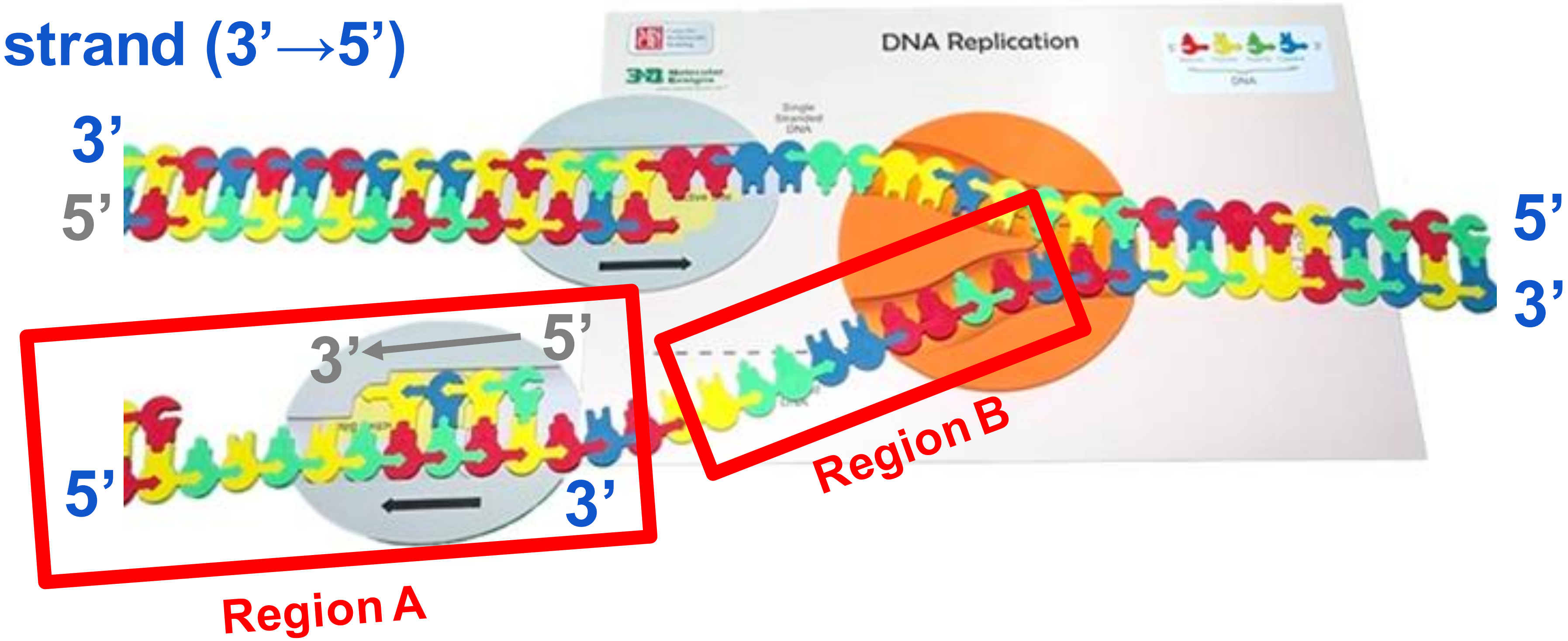
Based on the enzymatic property of DNA polymerase, <u>model</u> and <u>explain</u> what you think will happen.

Leading vs. Lagging Strands

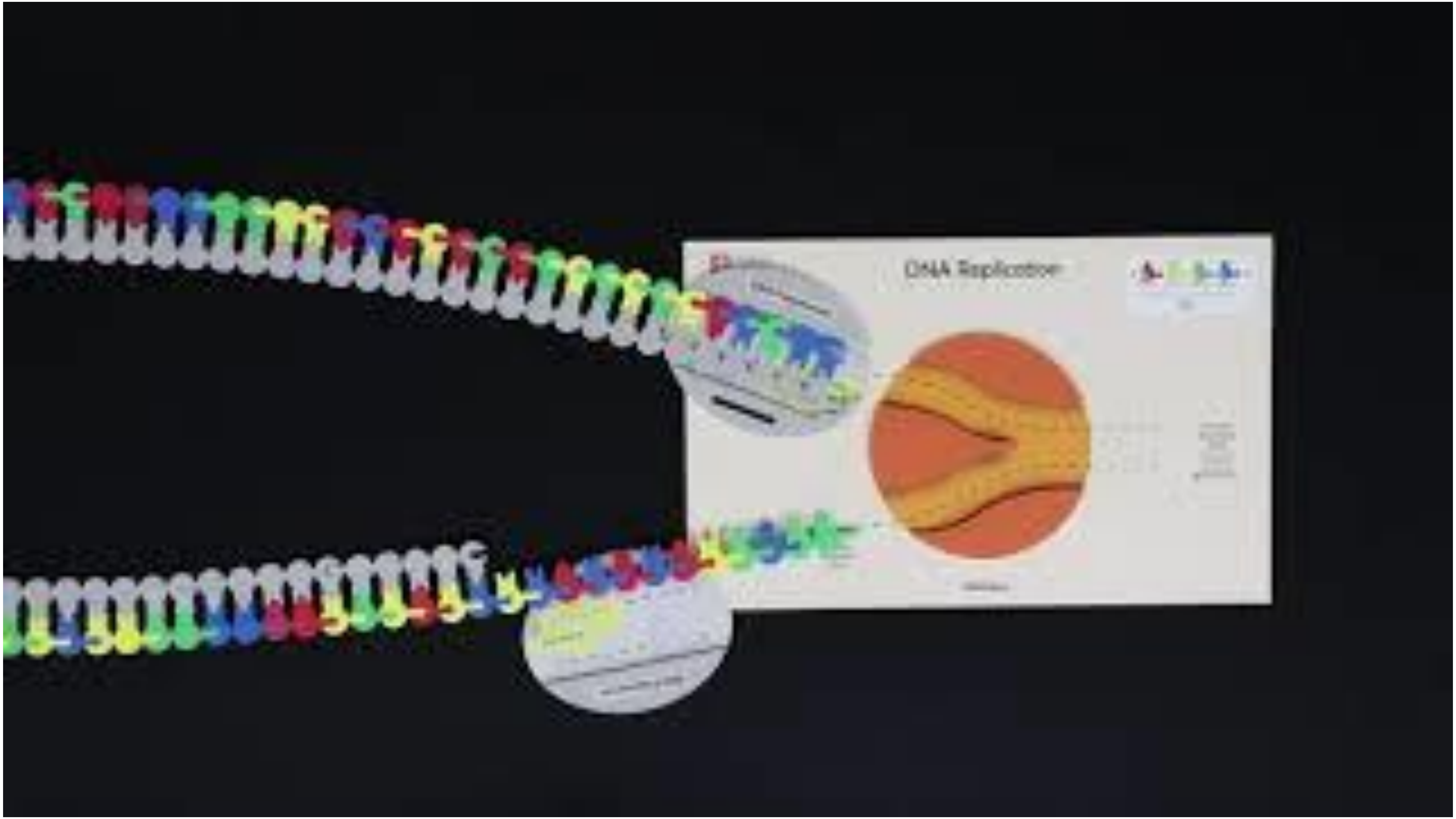


On the lagging strand, DNA is synthesized discontinuously in short sequences called Okazaki fragments

Leading strand (3'→5')



Lagging strand (5'→3')


DNA Replication

What are some "Aha Moments" *you* experienced as a learner during this activity?

What are important takeaways that *your students* will gain from <u>modeling</u> this process?

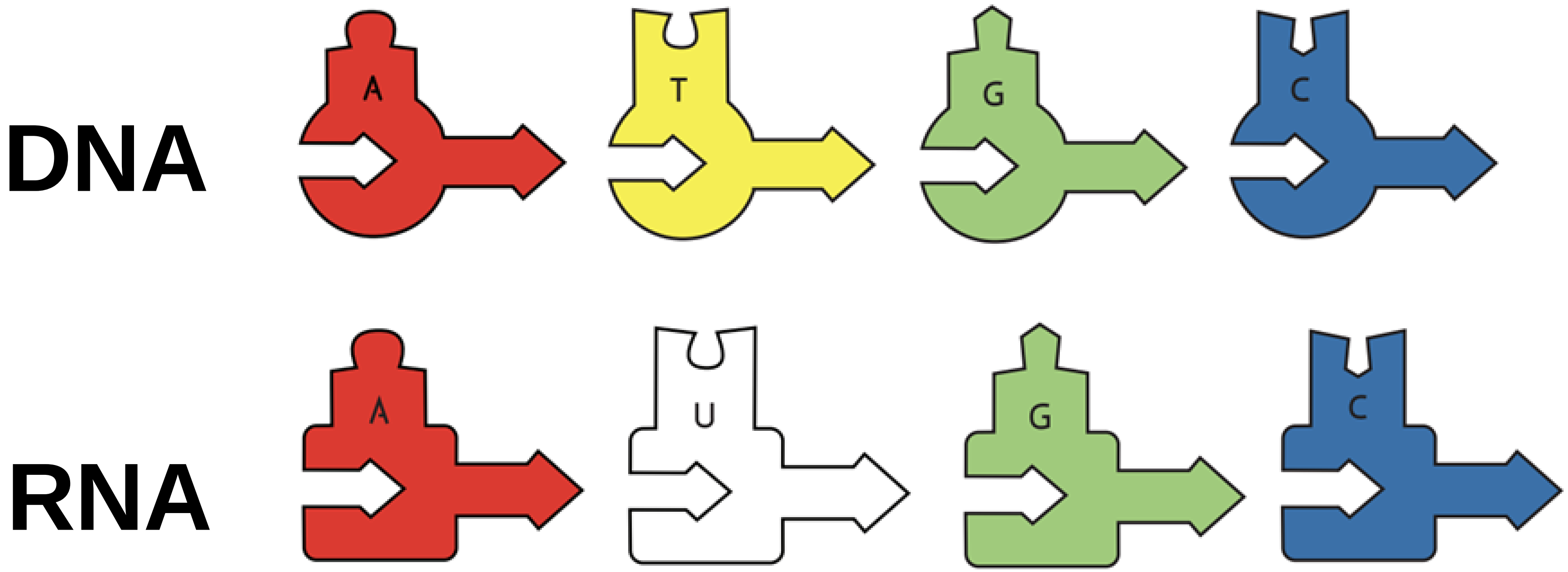
What are some limitations of this model?

Transcription

Materials Needed:

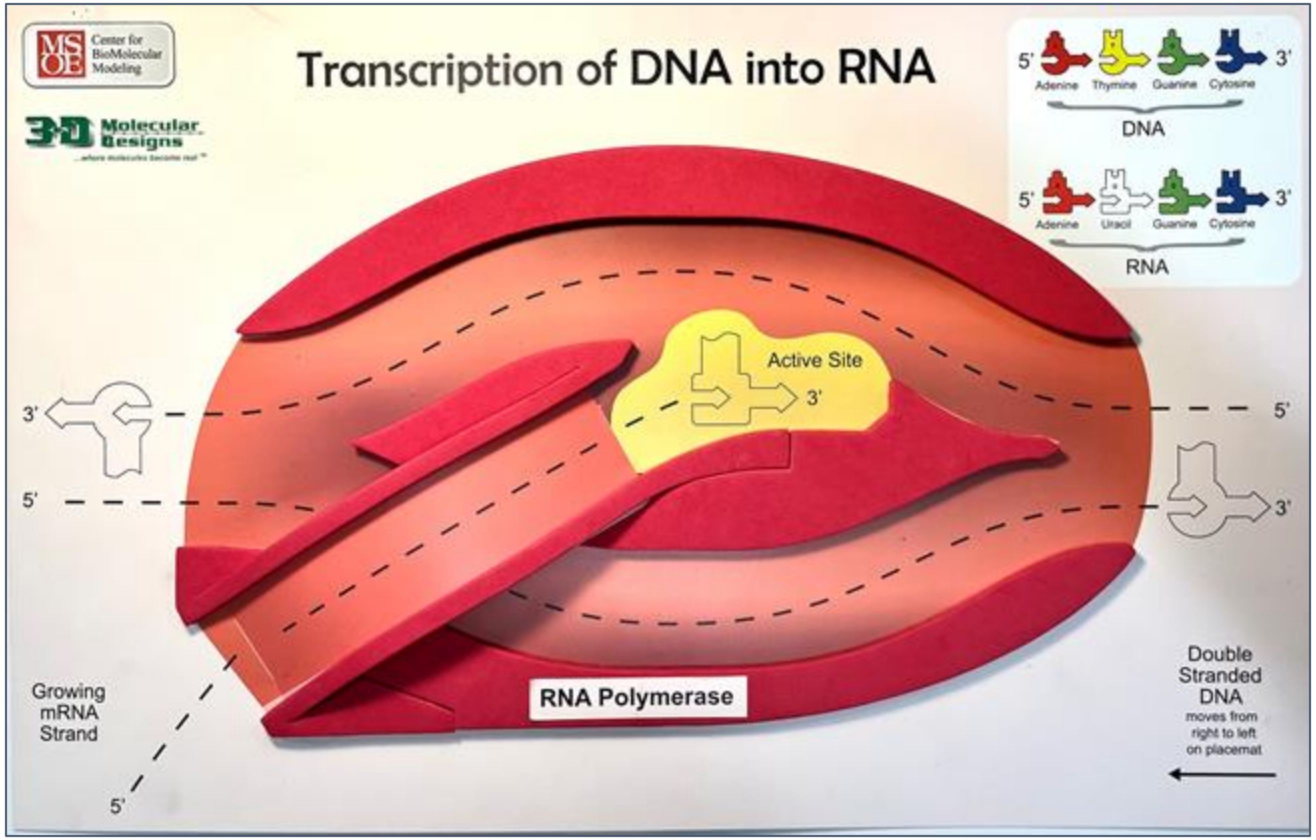
- Transcription Placemat (RNA polymerase)
- Double-stranded DNA sequence
- RNA nucleotides

DNA vs. RNA



How do these differ?

Transcription Enzyme: RNA Polymerase

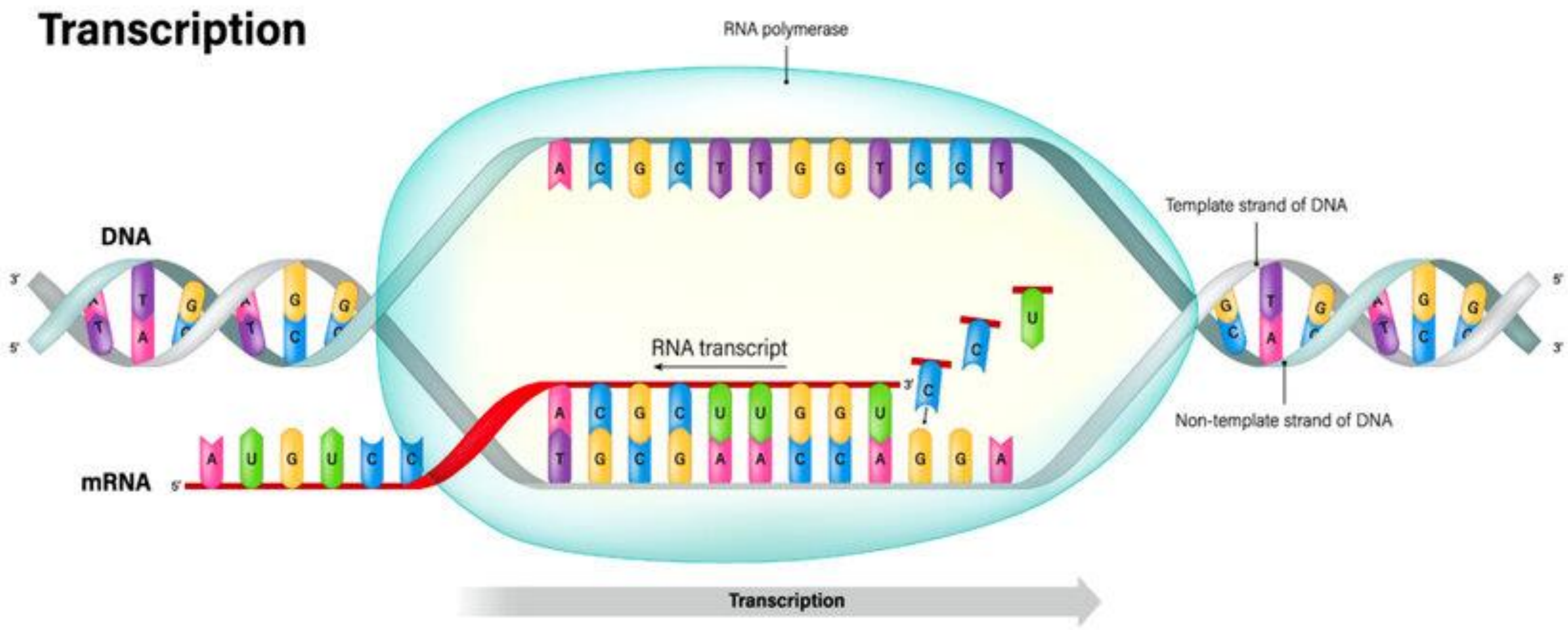


What do you notice? What do you wonder?

Transcription Tips:

- Double-stranded DNA template
- RNA: uracil (vs. thymine in DNA) pairs with adenine

Note: **RNA polymerase** adds the RNA nucleotides to the 3’ end of the growing RNA strand

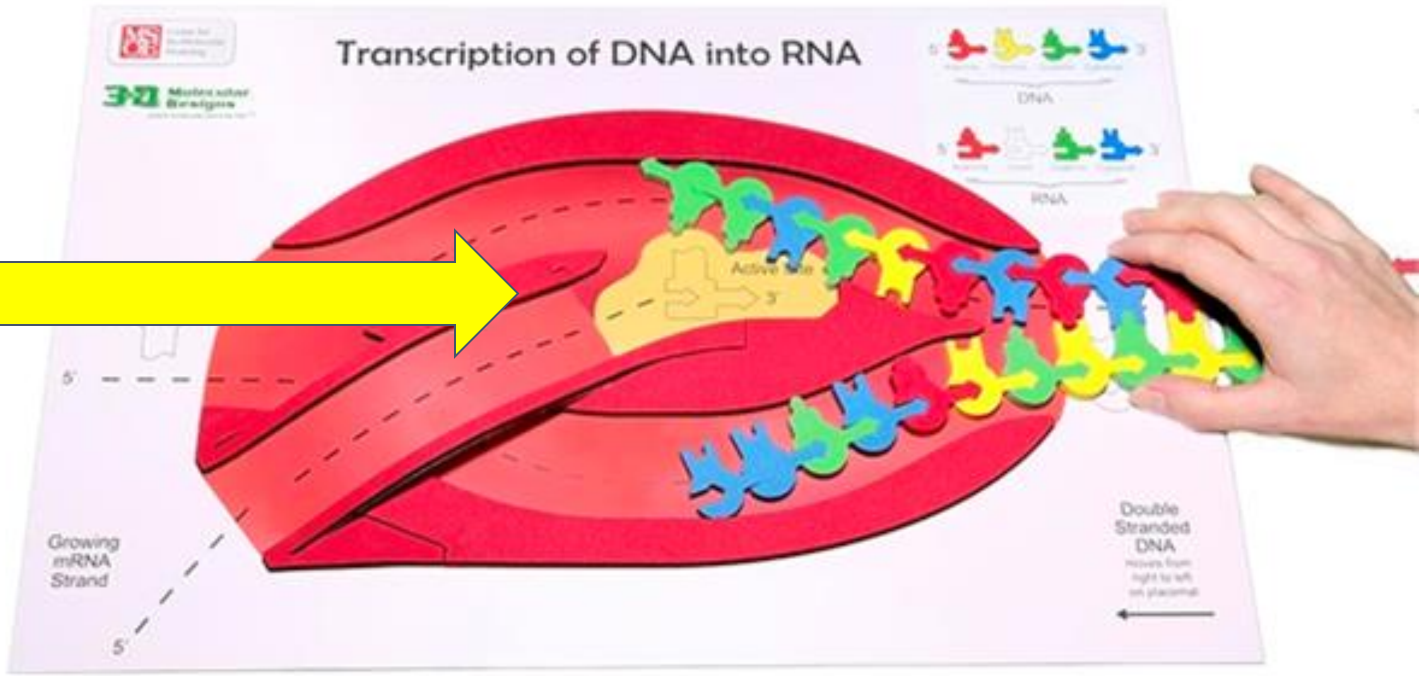


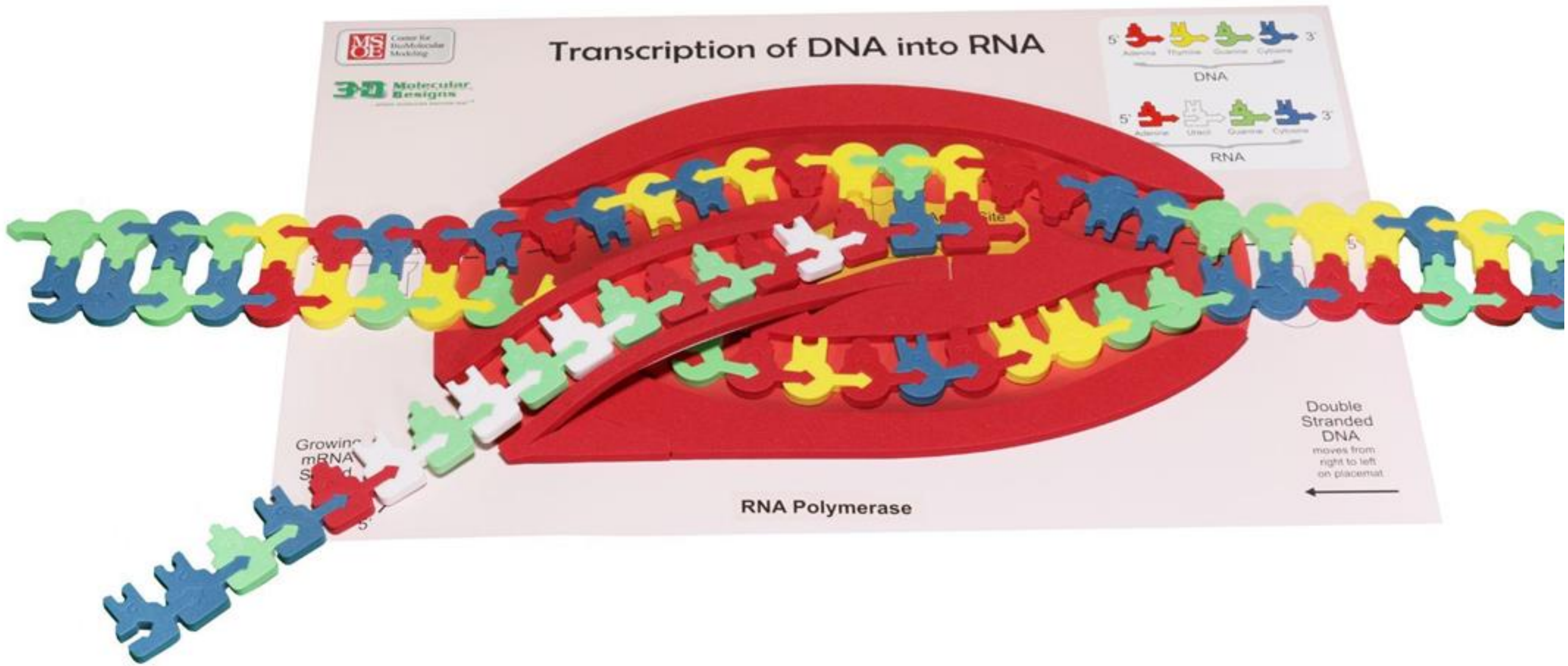
Transcription
RNA polymerase
DNA
Template strand of DNA
RNA transcript
Non-template strand of DNA
mRNA
Transcription

Model the Process of Transcription

RNA POLYMERASE unwinds DNA, synthesizes a single strand of RNA (complementary to DNA), which is elongated in the 5'→3' direction, and rewinds DNA

RNA polymerase moves




Transcription of DNA into RNA
DNA
RNA
Double Stranded DNA
moves from right to left on placemat
RNA Polymerase

What are some "Aha Moments" *you* experienced as a learner during this activity?

What are important takeaways that *your students* will gain from modeling this process?

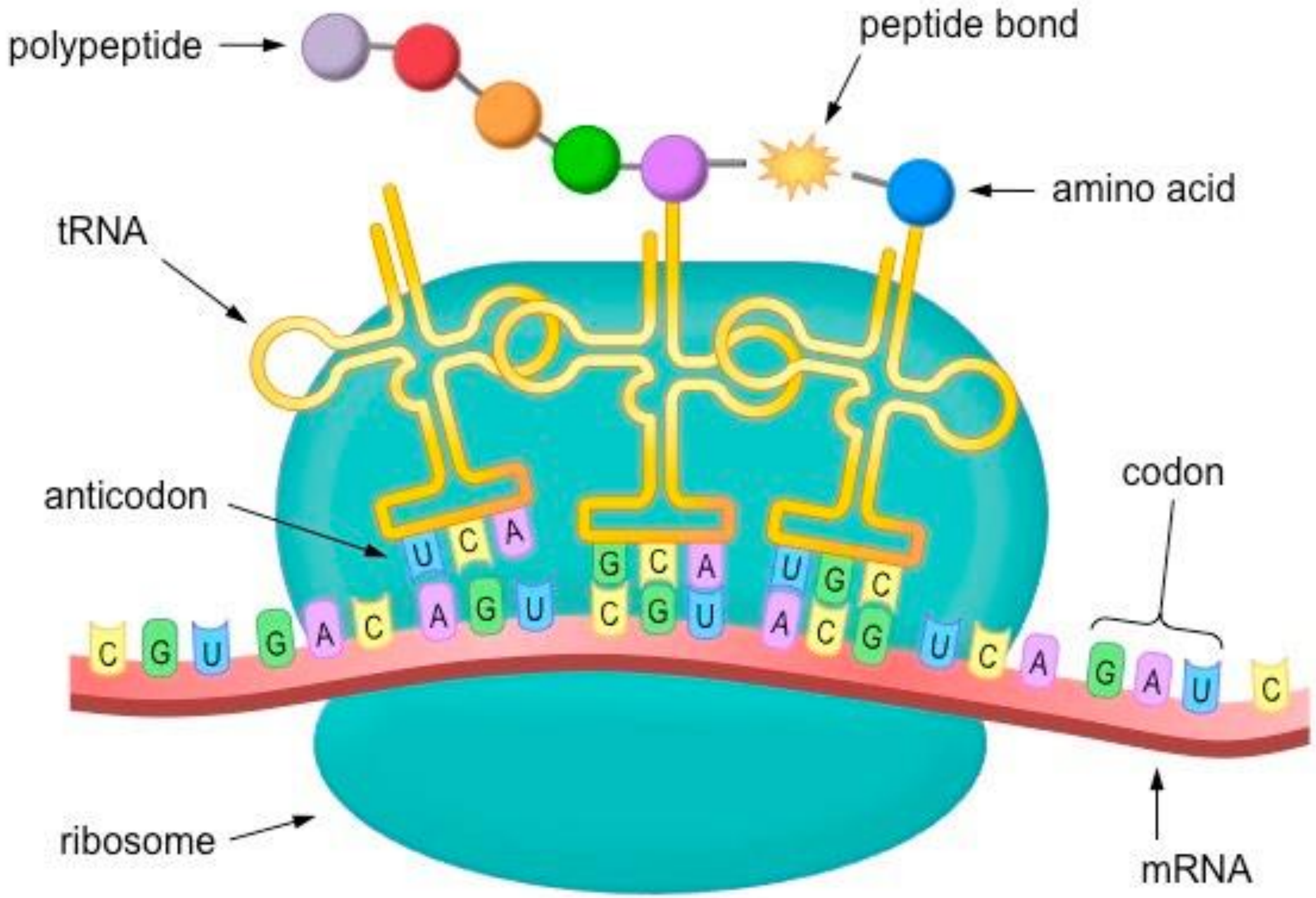
What are some limitations of this model?

Translation

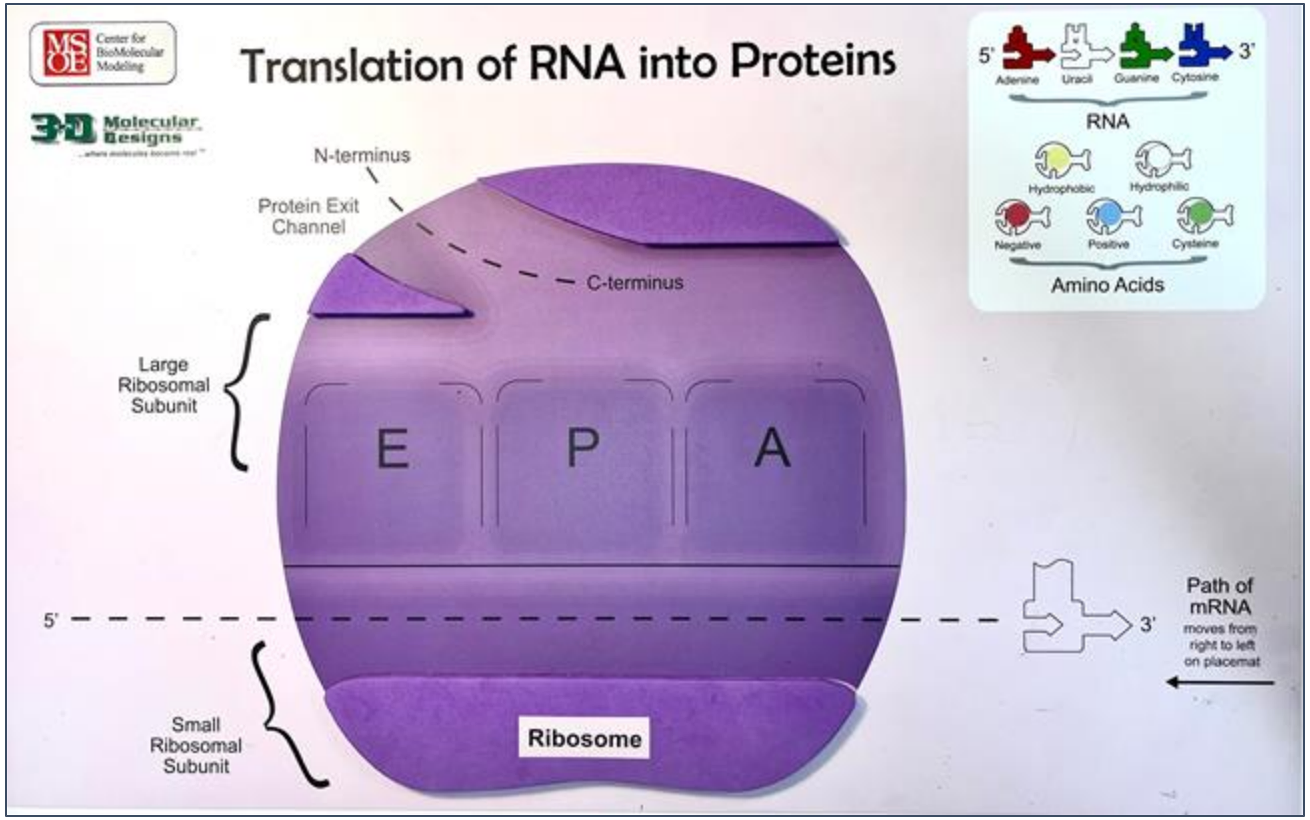
Materials Needed:

- Translation placemat (ribosome)
- mRNA strand (from transcription)
- Foam tRNAs, amino acids, stop codon
- Genetic codon chart/circle

Translation



Ribosome: Site of Protein Synthesis



What do you notice? What do you wonder?

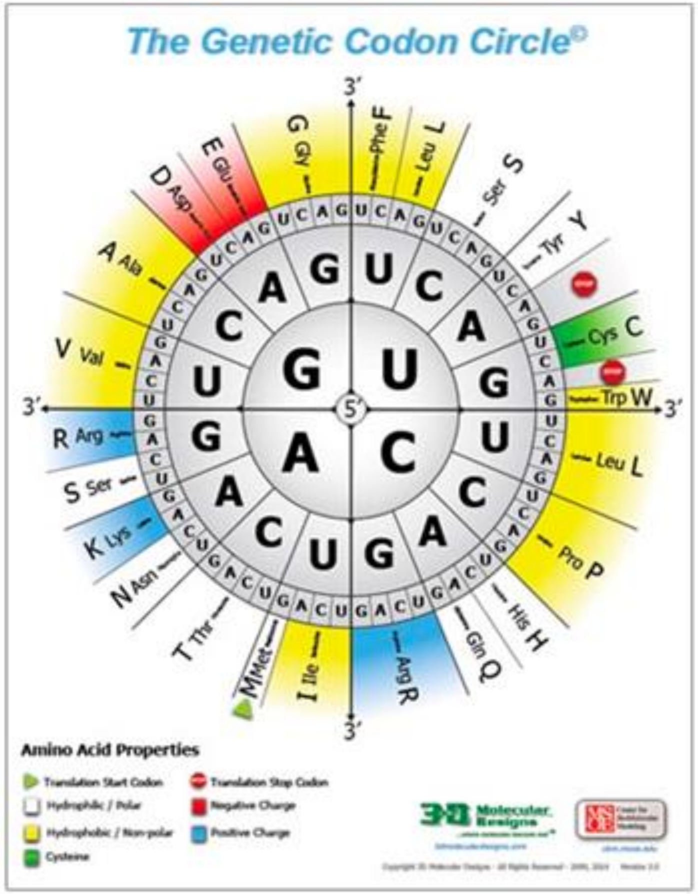
3d molecular designs

The Genetic Codon Chart©

	U	C	A	G	
U	UUU → Phe F	UCU → Ser S	UAU → Tyr Y	UGU → Cys C	U
	UUC → Phe F	UCC → Ser S	UAC → Tyr Y	UGC → Cys C	C
	UUA → Leu L	UCA → Ser S	UAA → Stop	UGA → Stop	A
	UUG → Leu L	UCG → Ser S	UAG → Stop	UGG → Trp W	G
C	CUU → Leu L	CCU → Pro P	CAU → His H	CGU → Arg R	U
	CUC → Leu L	CCC → Pro P	CAC → His H	CGC → Arg R	C
	CUA → Leu L	CCA → Pro P	CAA → Gln Q	CGA → Arg R	A
	CUG → Leu L	CCG → Pro P	CAG → Gln Q	CGG → Arg R	G
A	AUU → Ile I	ACU → Thr T	AAU → Asn N	AGU → Ser S	U
	AUC → Ile I	ACC → Thr T	AAC → Asn N	AGC → Ser S	C
	AUA → Ile I	ACA → Thr T	AAA → Lys K	AGA → Arg R	A
	AUG → Met M	ACG → Thr T	AAG → Lys K	AGG → Arg R	G
G	GUU → Val V	GCU → Ala A	GAU → Asp D	GGU → Gly G	U
	GUC → Val V	GCC → Ala A	GAC → Asp D	GGC → Gly G	C
	GUA → Val V	GCA → Ala A	GAA → Glu E	GGA → Gly G	A
	GUG → Val V	GCG → Ala A	GAG → Glu E	GGG → Gly G	G

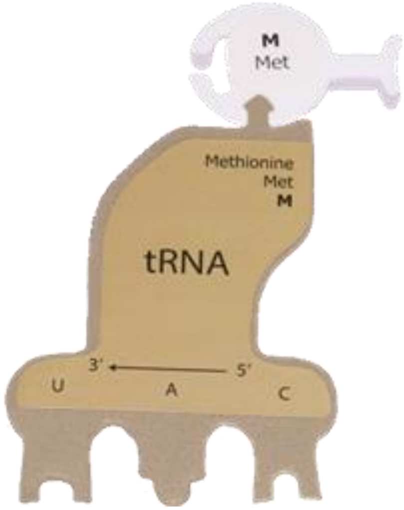
Amino Acid Properties

- Translation Start Codon
- Translation Stop Codon
- Hydrophobic / Non polar
- Hydrophilic / Polar
- Negative Charge
- Positive Charge
- Cysteine



What will you need to pre-teach your students about the mRNA Codon Chart (or Circle) before modeling the process of translation?

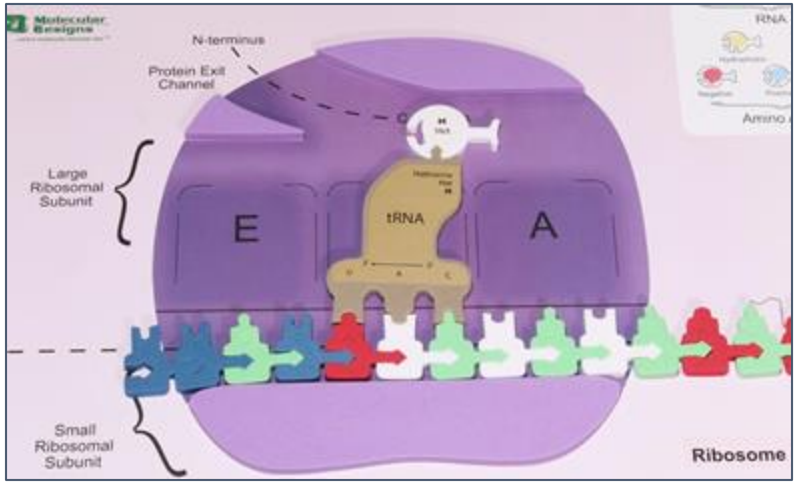
Part 1:
Attach amino acids to tRNAs



Kit provides 2 histidines and 2 cysteines

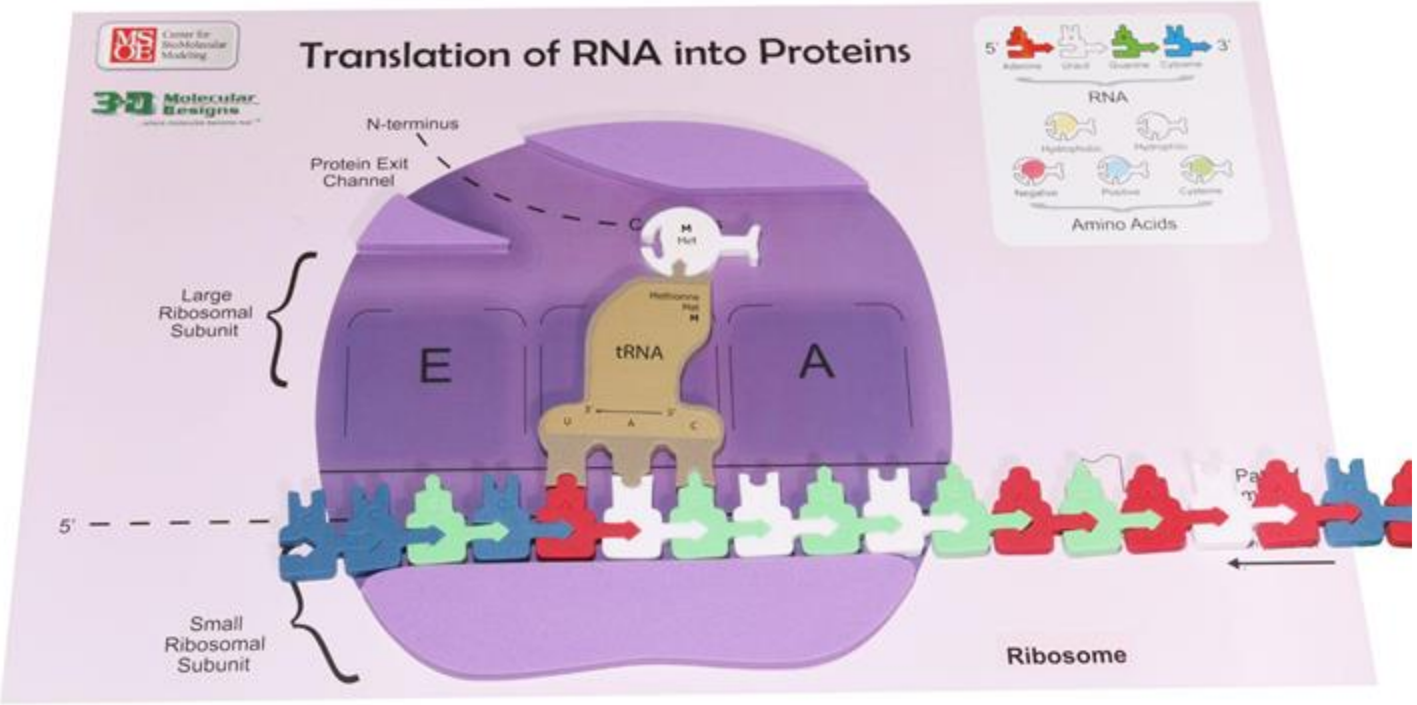
- Histidines: shows redundancy in the mRNA codons
- tRNA for cysteine is *reused*

Part 2:
Polypeptide synthesis

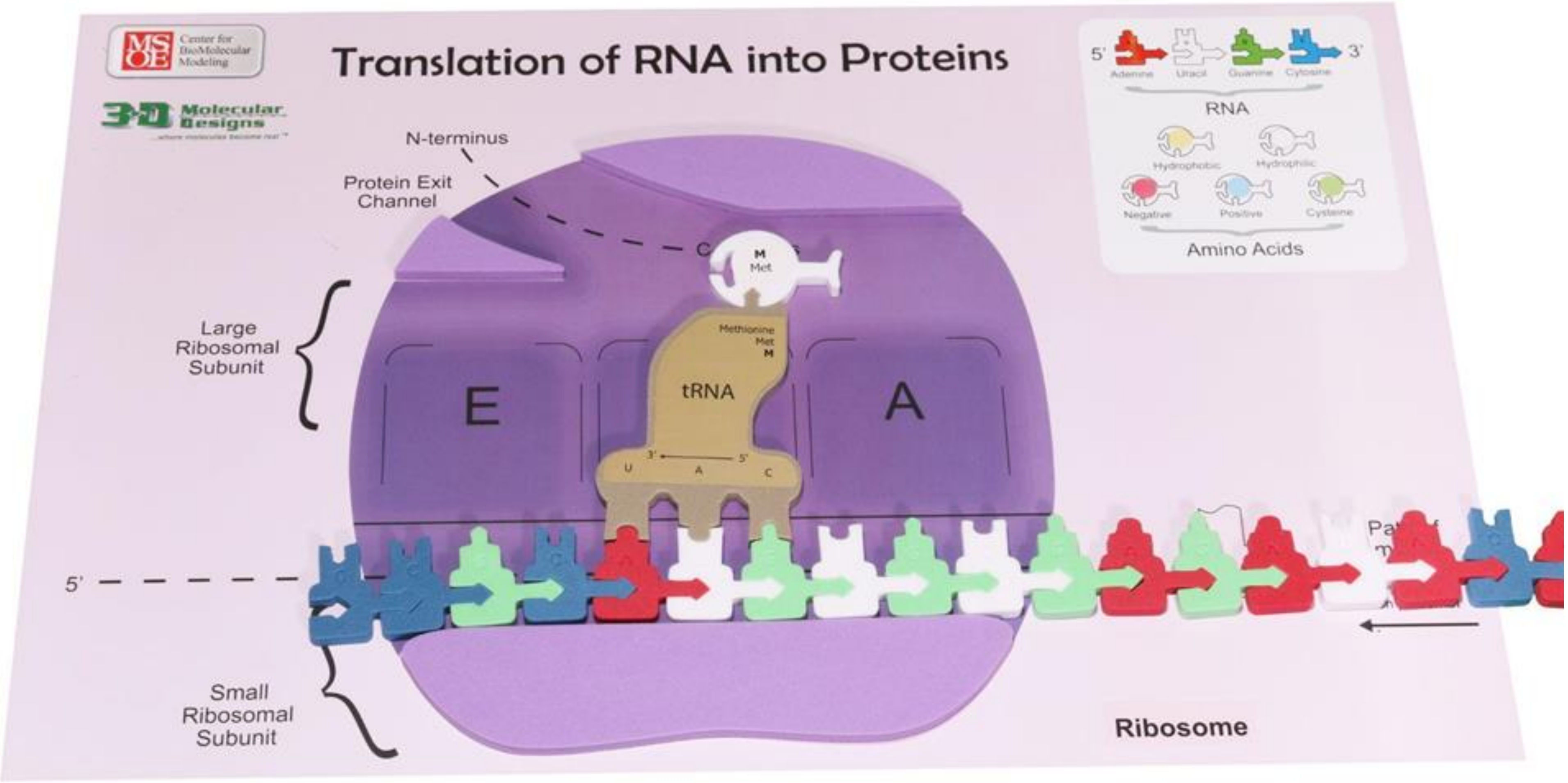


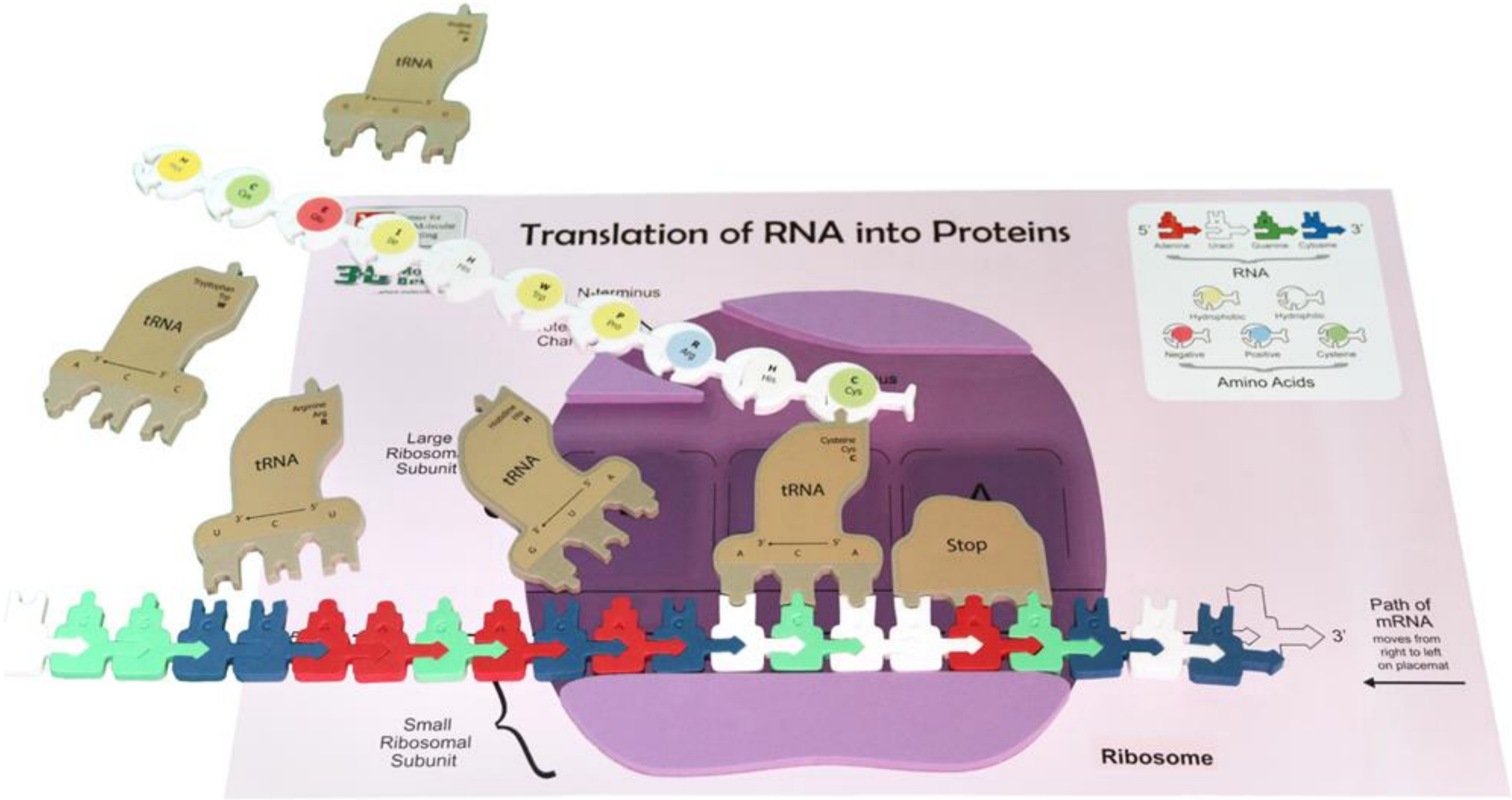
Translation Tips:

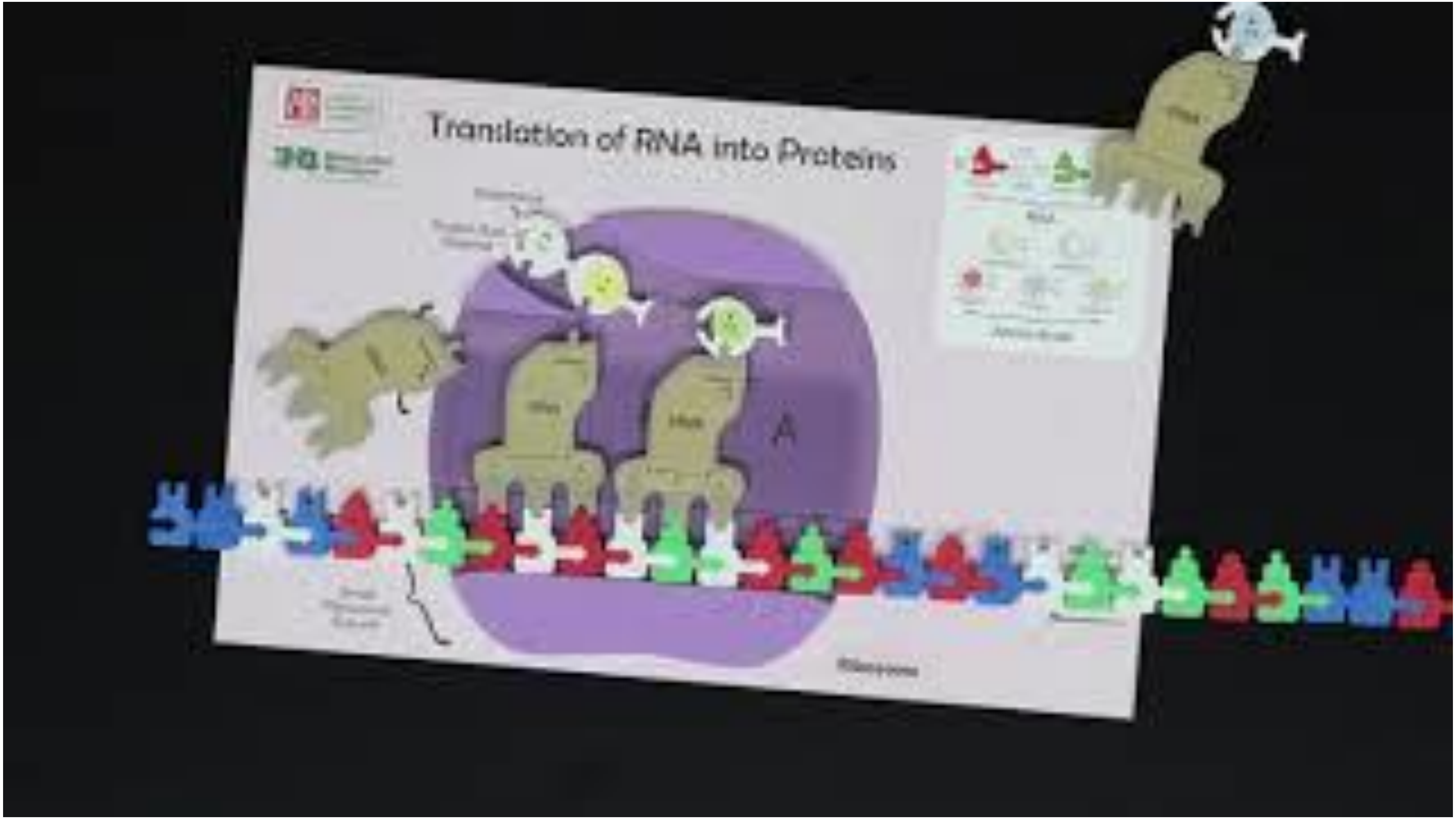
- mRNA template needed (from transcription)
- Translation begins at AUG (start codon)
- Translation ends with UAG (stop codon)



Model the Process of Transcription




Translation of RNA into Proteins
tRNA
tRNA
tRNA
tRNA
tRNA
N-terminus
Large
Ribosomal
Subunit
Stop
RNA
Amino Acids
Path of
mRNA
moves from
right to left
on placemat
3'
Small
Ribosomal
Subunit
Ribosome


Translation of RNA into Proteins
A

What are some *challenges* you experienced as a learner during this activity?

What are some tips you have for facilitating this activity successfully with your students?

What are some limitations of this model?

Ideas for capturing student learning

- Stop motion animation
- Comic strip panels
- Video demonstrations
- Infographic (with photos and captions)
- Gallery walk / Interactive Exhibit

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- DNA Helicase Molecule of the Month

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Presenter: Chris Chou

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CLEAN UP
TIME

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