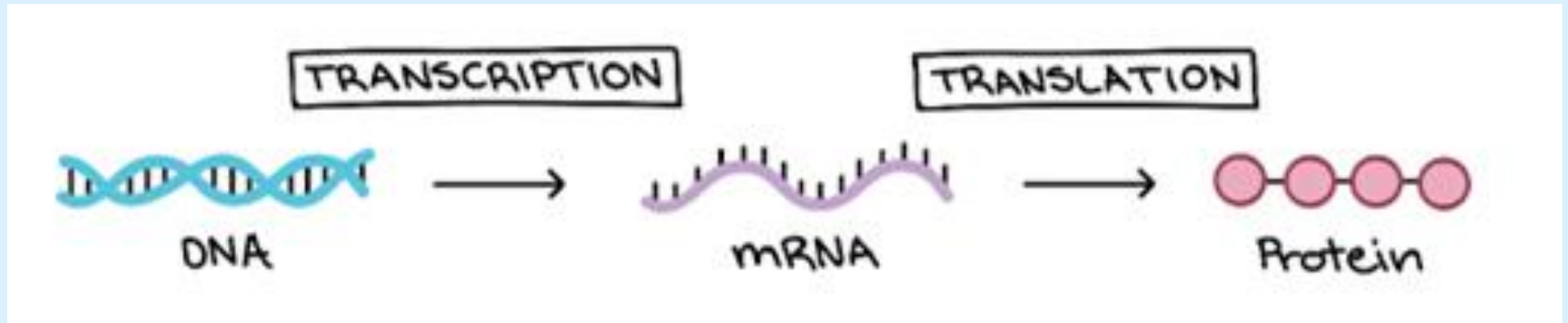


Going With the Flow

From Genes to Proteins



Mark Eberhard

St. Clair High School in St. Clair, MI

38 years in the biology classroom

3DMD Model Teacher, Board of Directors for Michigan Association of Biology Teachers, HHMI Biointeractive Ambassador, Writing Team for College Board's Pre-AP Biology, AP Biology Reader

NABT Outstanding Biology Teacher 2020 for Michigan

Email = meberhard@ecsd.us



Who is With Us Today?

- Where are you from?
- What is your role in science education?
- How long have you been in science education?
- How familiar are you with modeling kits from 3D Molecular Designs and the Center for Biomolecular Modeling?



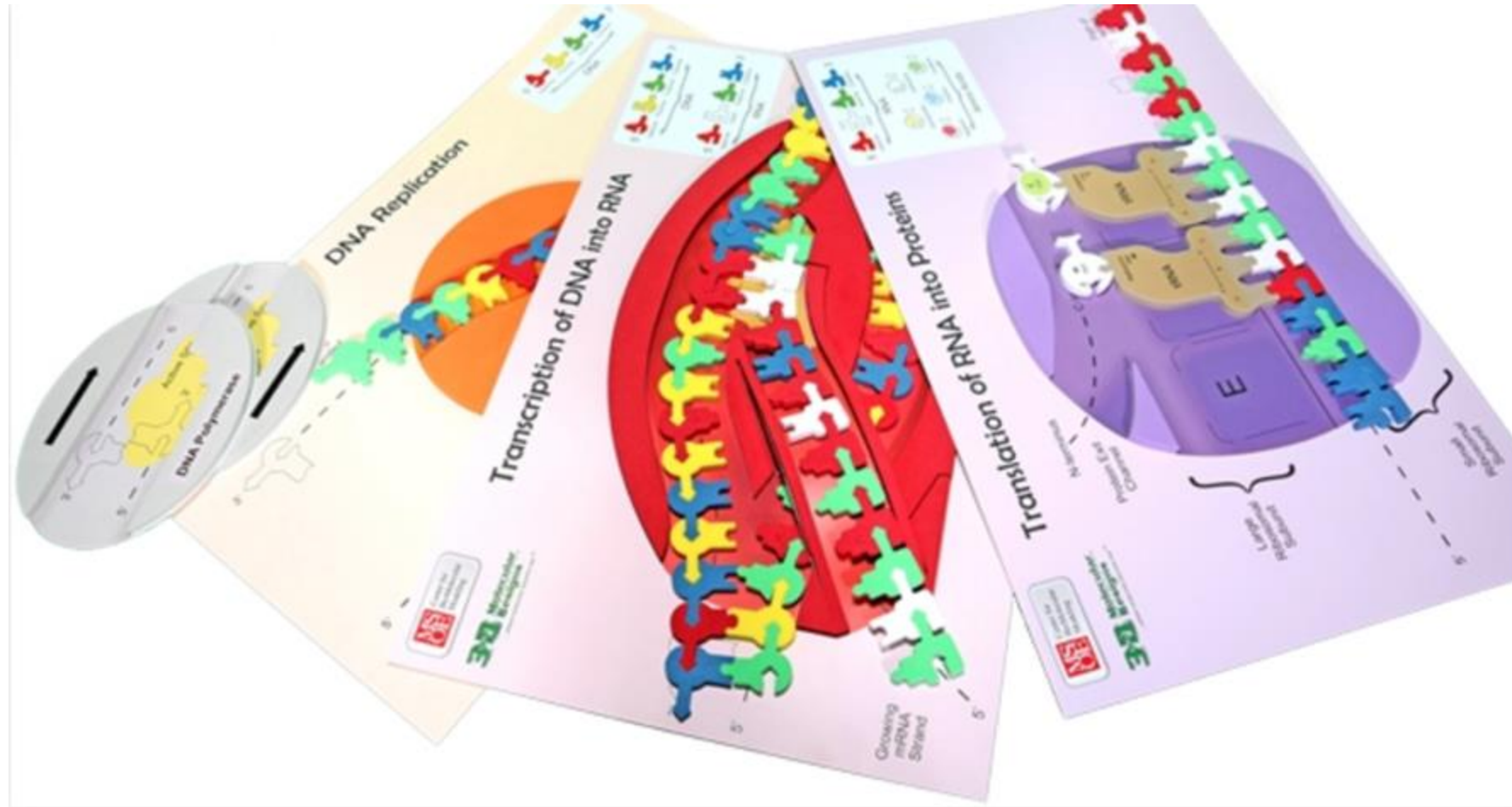
Workshop Goals

- Model and explain how the information stored in genes is transcribed and translated into a functional protein
- Recognize and address a weakness found in a model
- Connect knowledge from your current modeling activity to a previous modeling activity: help students make connections between newly acquired knowledge and prior knowledge
- Describe how a mutation in the DNA may lead to a change in its 3D shape that may alter its function





Flow of Genetic Information Kit (FGIK)





3D Molecular Designs and the Center for Biomolecular Modeling Merged Summer, 2022



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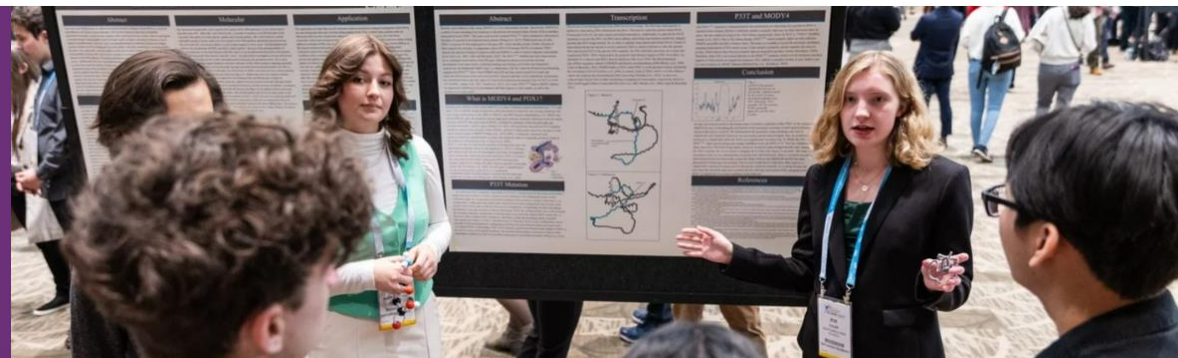
Hands-On Science Learning For All

Learn More



SMART Teams

Students Modeling A Research Topic



Welcome to the SMART Teams Protein Modeling Program!

We have taken the main features of our past student modeling programs (SMART and MAPS) and combined them into one set of resources.

In SMART Teams, small groups of students led by a facilitator use hands-on modeling activities and online digital resources to discover basic molecular concepts. They will read a research paper and use protein structure data to “design” and 3D print a model of the protein, which will help them tell their structure-function story in a capstone event presentation.

Register Your Team Today!

Your registration fee gives you instant access to:

- All 4 phases of the SMART team modeling program
- Modeling resources, including a molecule builder and Jmol explorer page
- Access to new Insulin and Aquaporin Protein Stories
- Access to an archived Antibodies Protein Story
- 3DMD Staff Assistance with abstract writing, Jmol modeling, and poster assistance
- A full-color 3D print of your model design

Register Your SMART Team!

What Does it Mean to "Design" a Protein Model?

Creating a physical model of a protein structure is a key component of the SMART team program.

But what does it really mean to “design” a protein model? It means you explore a protein structure in a molecular visualization program, and then simplify the way the protein is visually displayed to make the key features of the protein more obvious to help communicate your molecular story.



[SMART Teams \(3dmoleculardesigns.com\)](https://3dmoleculardesigns.com)



Each Kit has links:

- Teacher notes
- Lessons
- Digital modeling activities
- Animations and videos
- Online resources
- NGSS Standards



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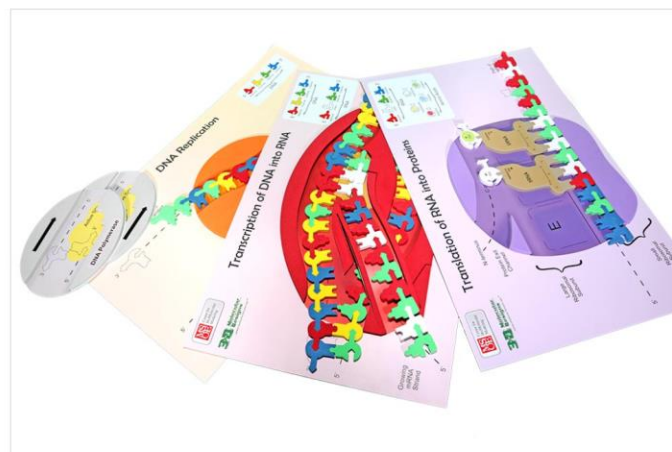
Kits & Models ▾

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Custom Models

About Us



Flow Of Genetic Information Kit[®]

The Central Dogma of Biology makes sense when your students can make it happen right before their eyes. Don't be surprised if someone blurts **"Now I get it!"** while using this kit. You can also purchase the Side Chain Expansion Pack or use the side chains from the Amino Acid Starter Kit[®] to add even more authenticity and connections!

- Identify essential enzymes like helicase and polymerase
- Model replication of the leading and lagging strands of DNA
- Explore transcription as they copy one strand of DNA into mRNA using an RNA polymerase
- Engage in translation/protein synthesis as they decode the mRNA into protein on the ribosome placemat
- Reenact the different results of the Meselson and Stahl experiments

You can also purchase the Side Chain Expansion Pack or use the side chains from the **Amino Acid Starter Kit[®]** to add even more authenticity and connections!

Learn more about the **Flow of Genetic Information Kit[®]**

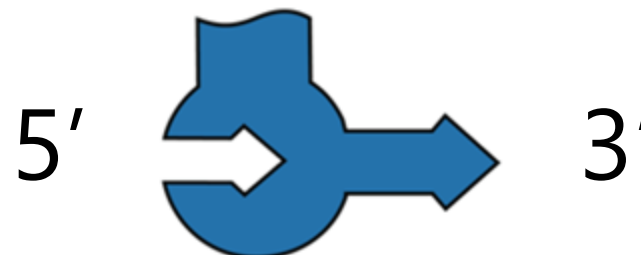
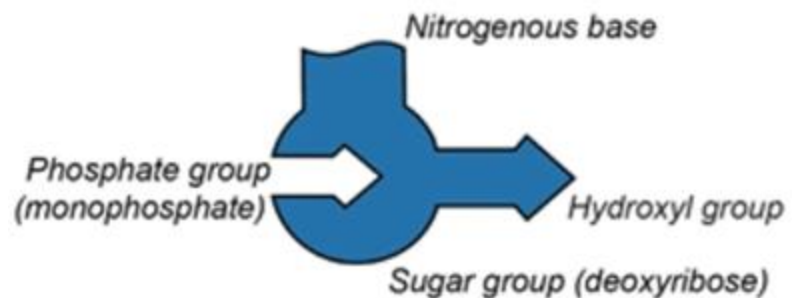
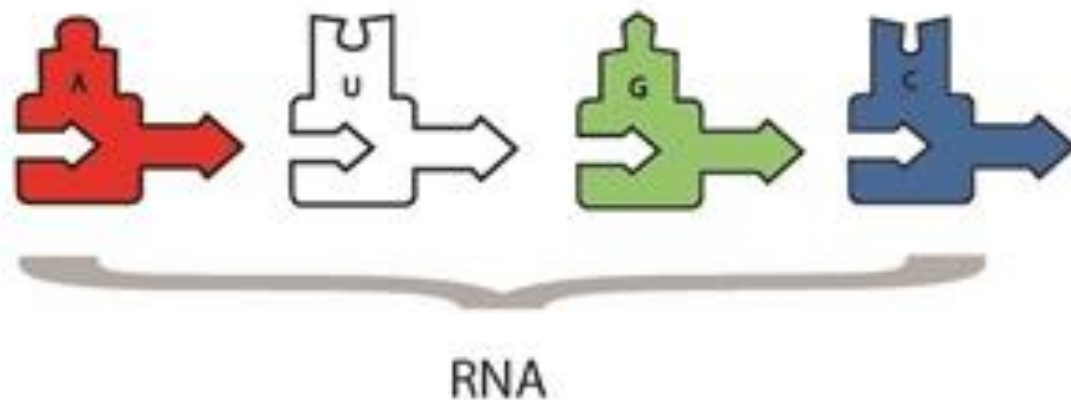
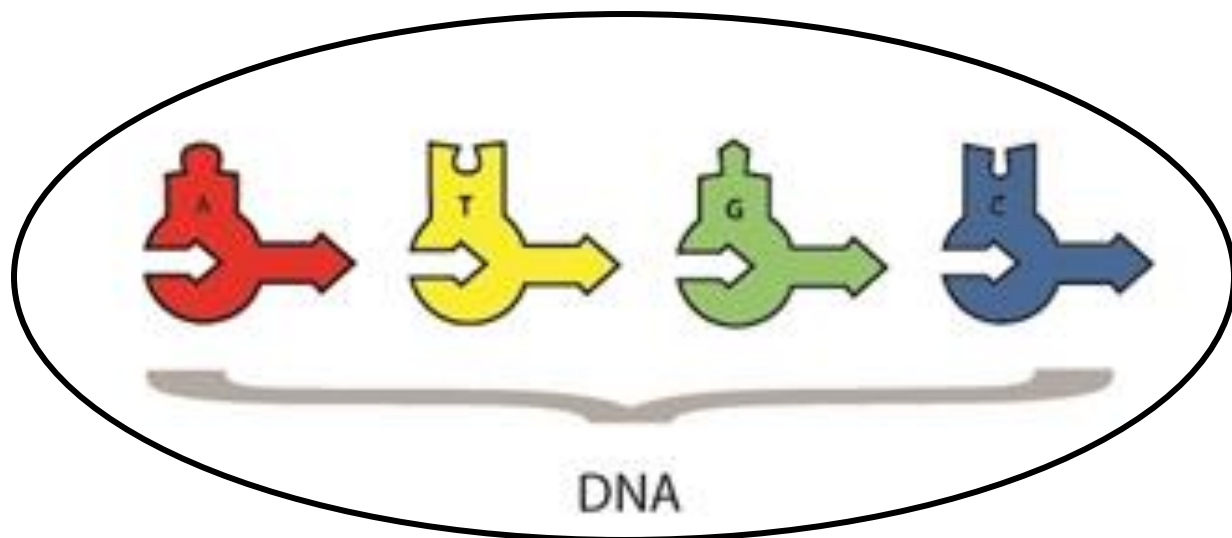


www.3dmoleculardesigns.com

Let's Get Ready to Begin!

Prior to this activity my students have learned about DNA structure, and protein folding and have used the Replication component of this model kit.

Nucleotides - DNA versus RNA



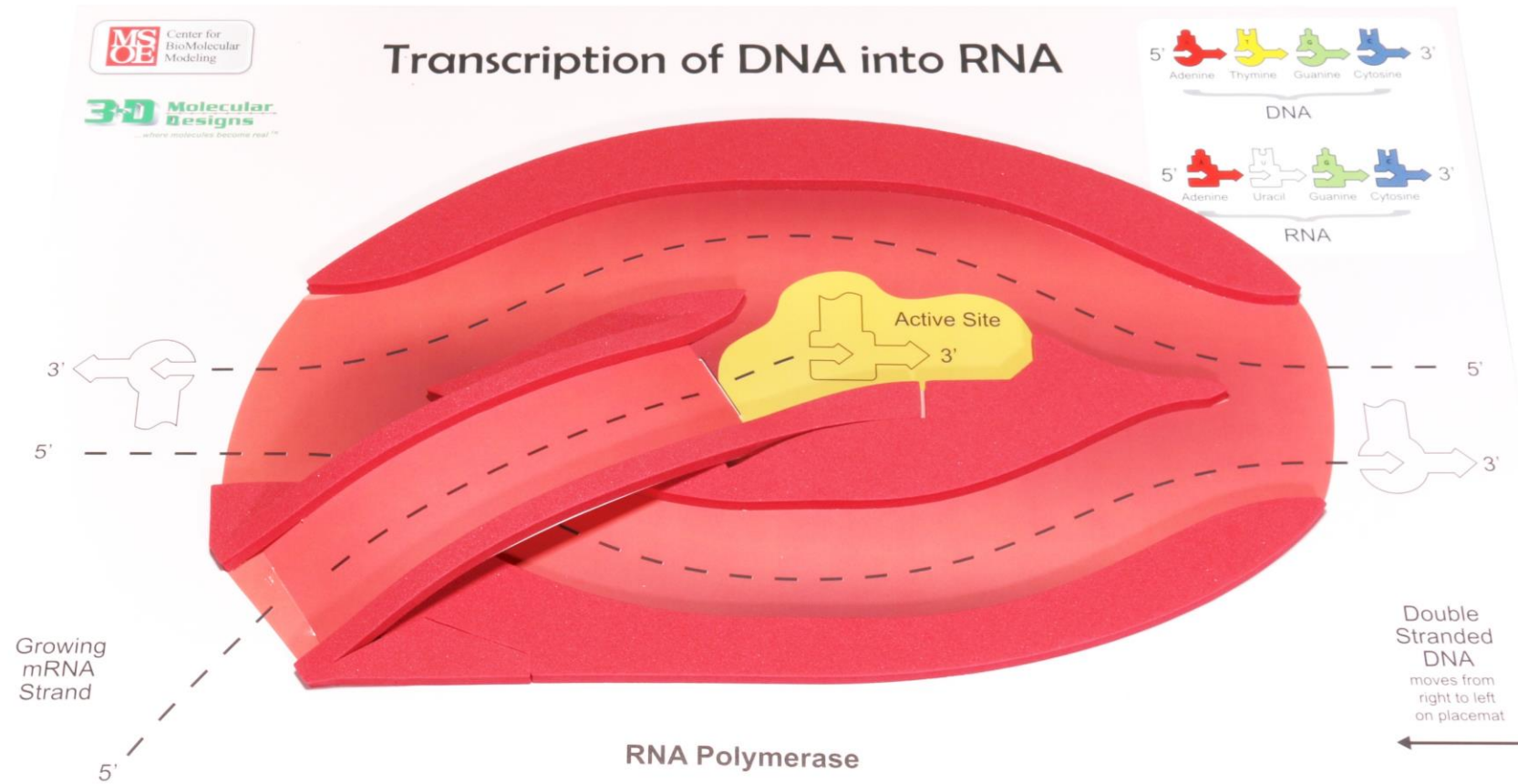
Please Orientate Your DNA Sequence ...



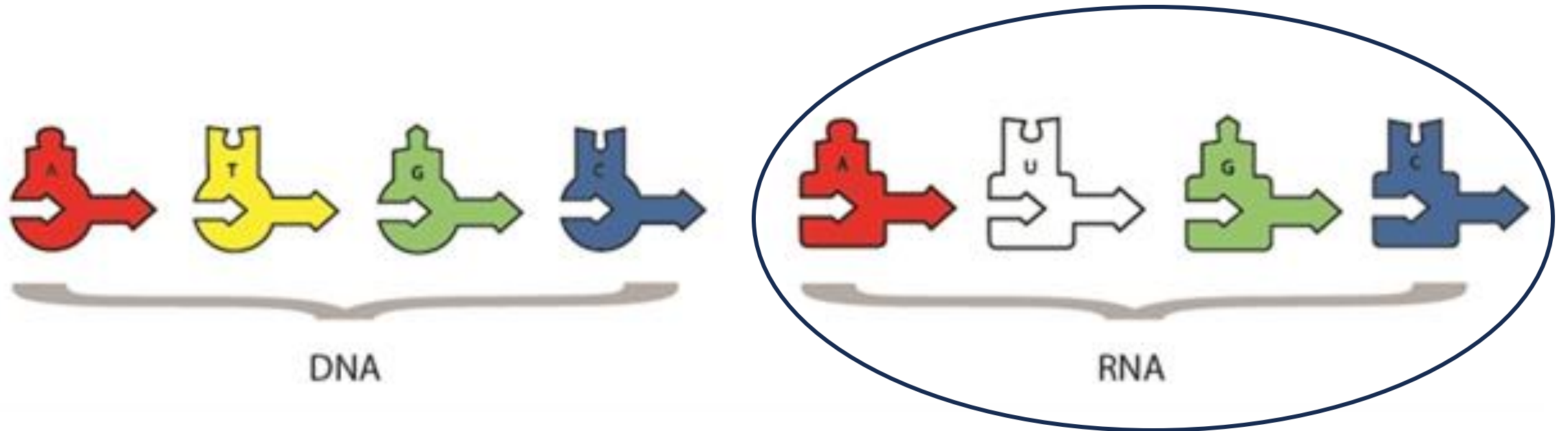
Top DNA strand ($3' \rightarrow 5'$) arrow points to the **LEFT**,
Bottom strand ($5' \rightarrow 3'$) arrow points to the **RIGHT**

Transcription

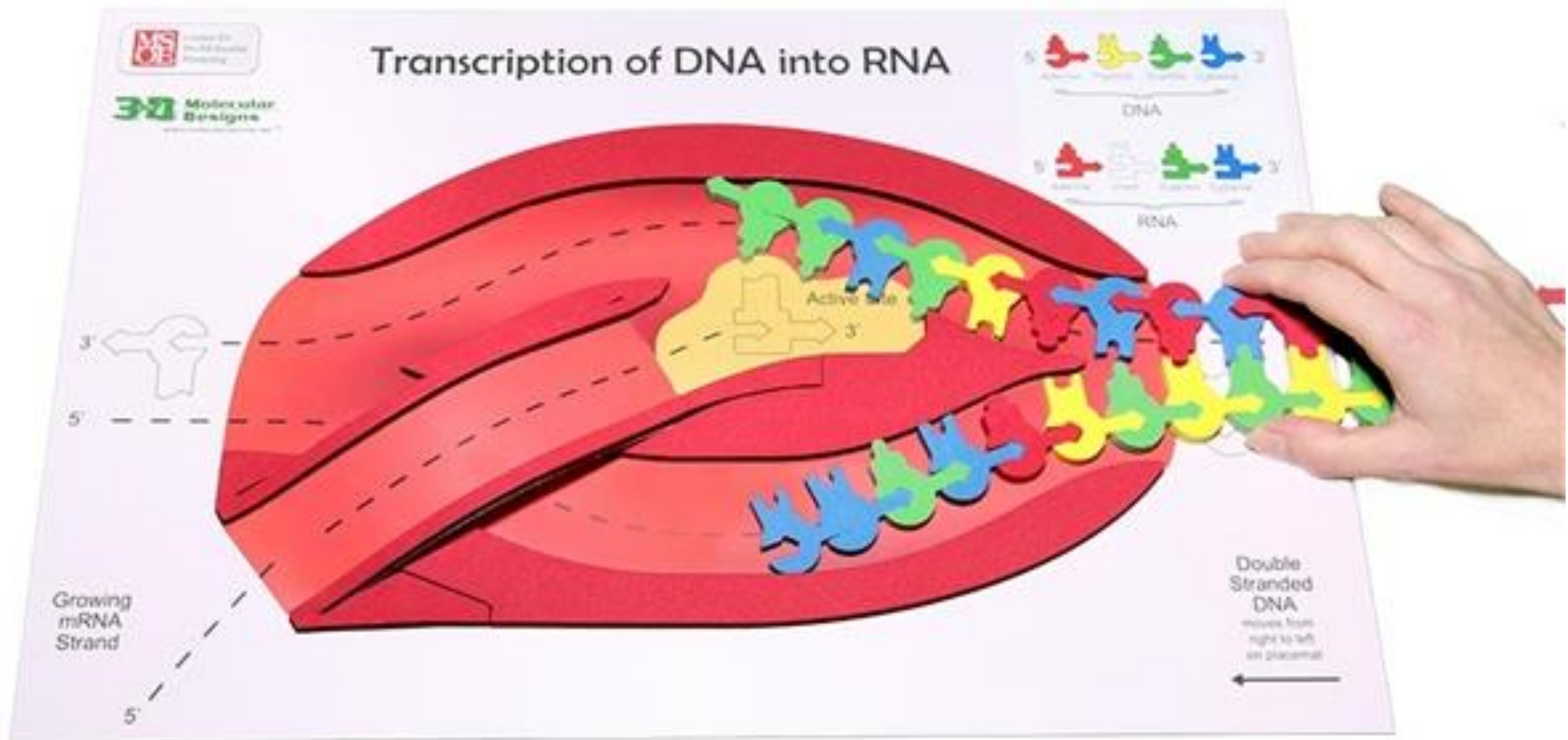
Transcription Placemat ...



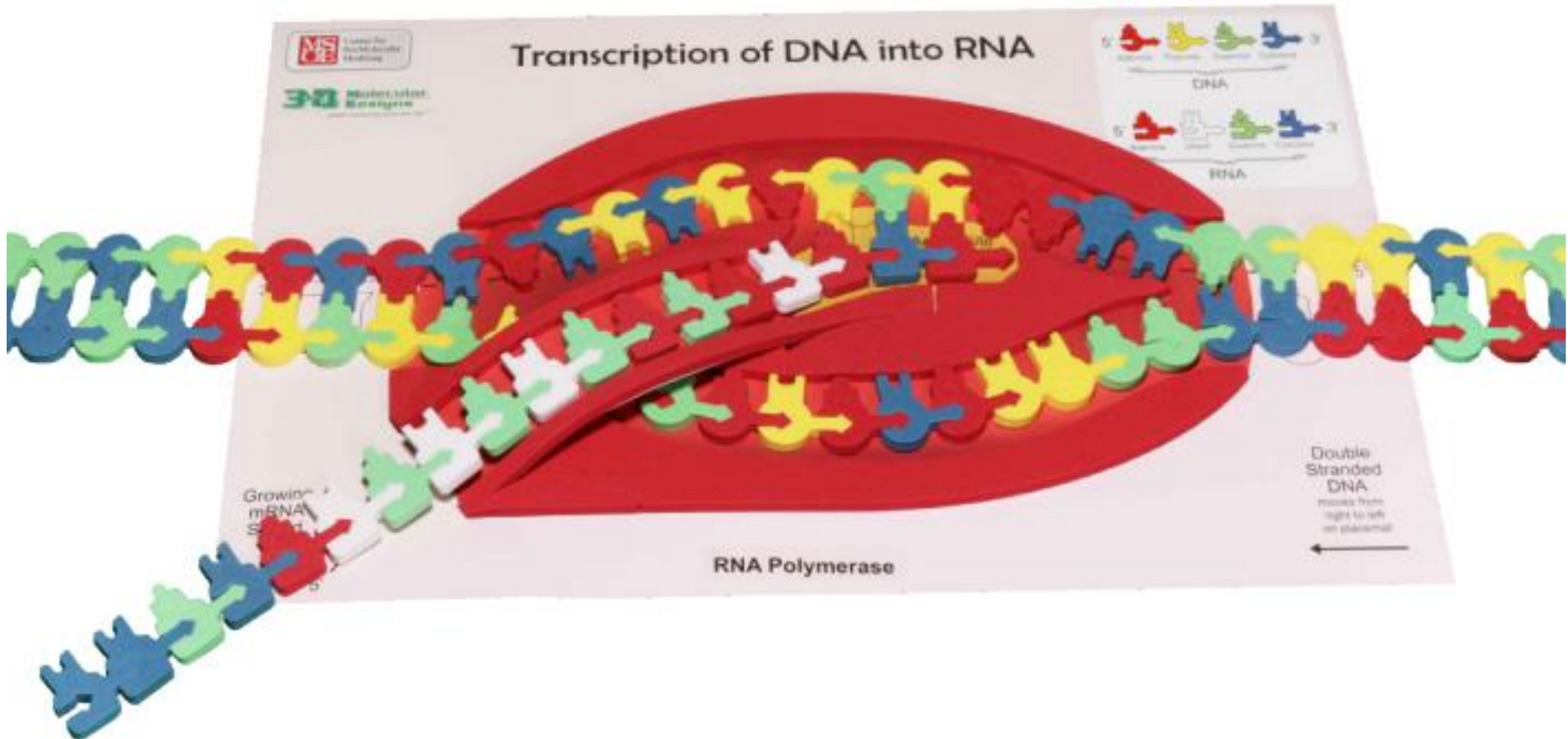
Nucleotides - DNA versus RNA



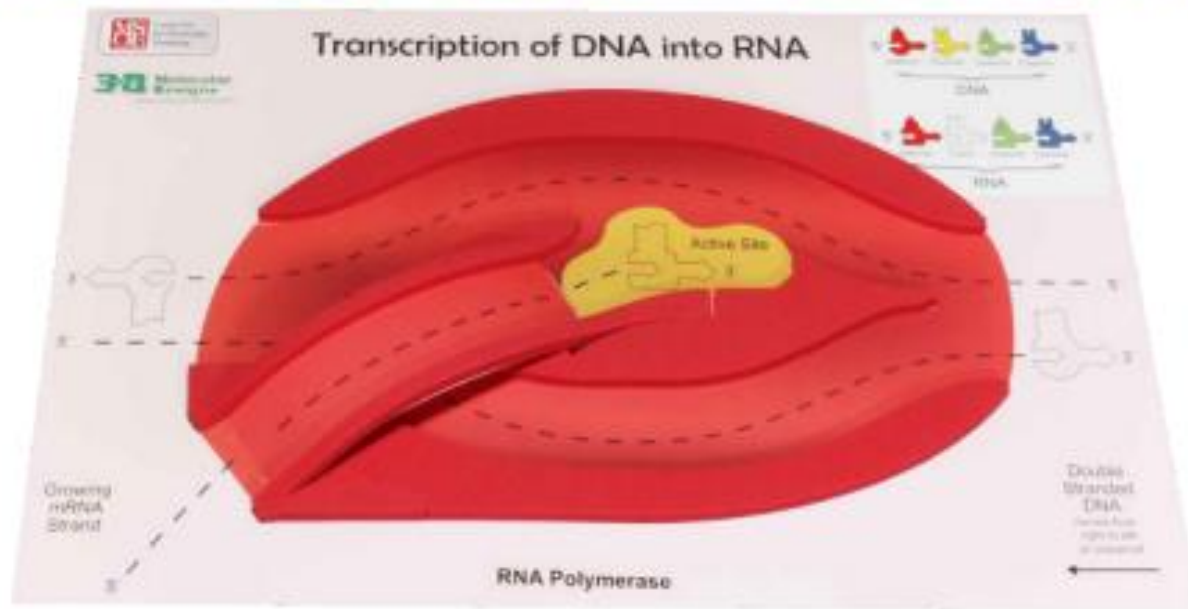
Initiation



Elongation



Termination





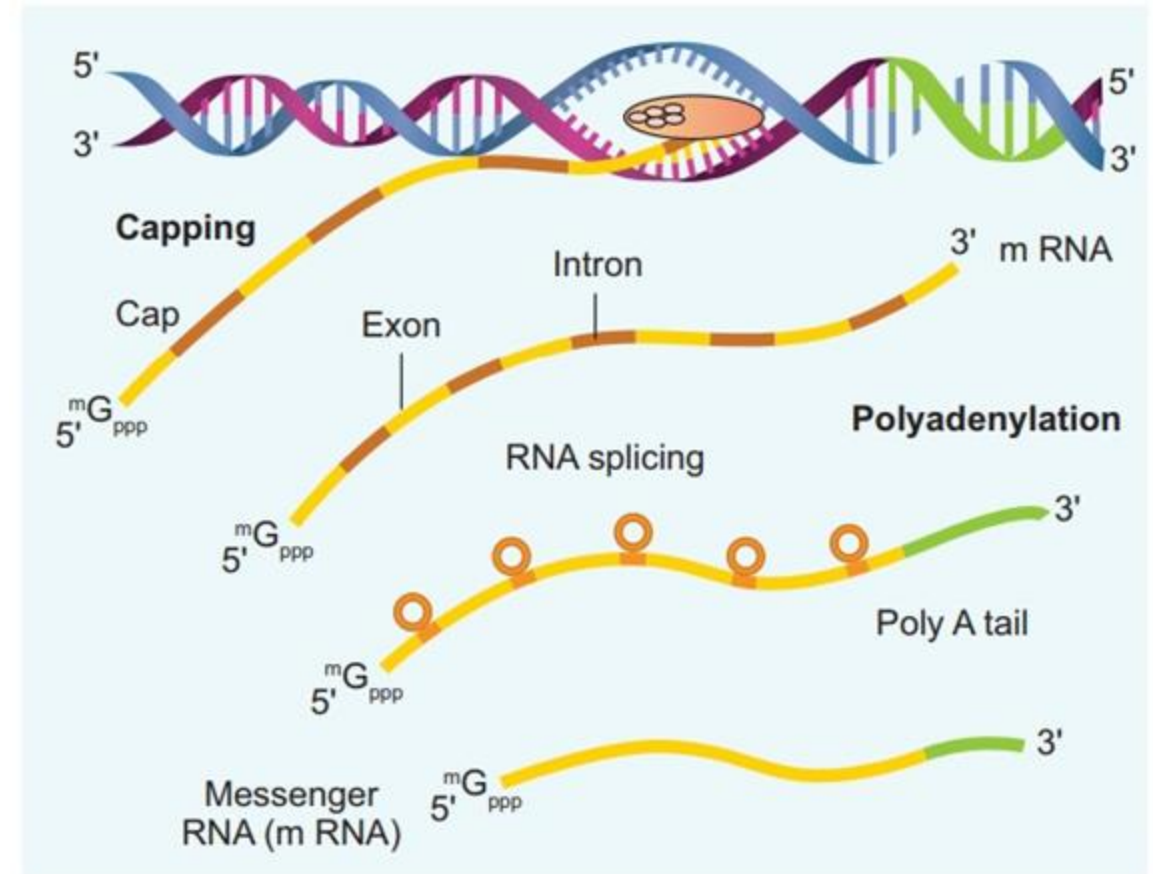
Student Products

- Stop Motion
- Video
- Photos & Google Slides
- Peer Review Presentations



ALL Models have weaknesses!

- What if I want my students to model mRNA processing of **introns** and **exons**?
- What if I want my students to model the **5' G-cap** or the **poly-A tail**?
- Put the challenge to your students!



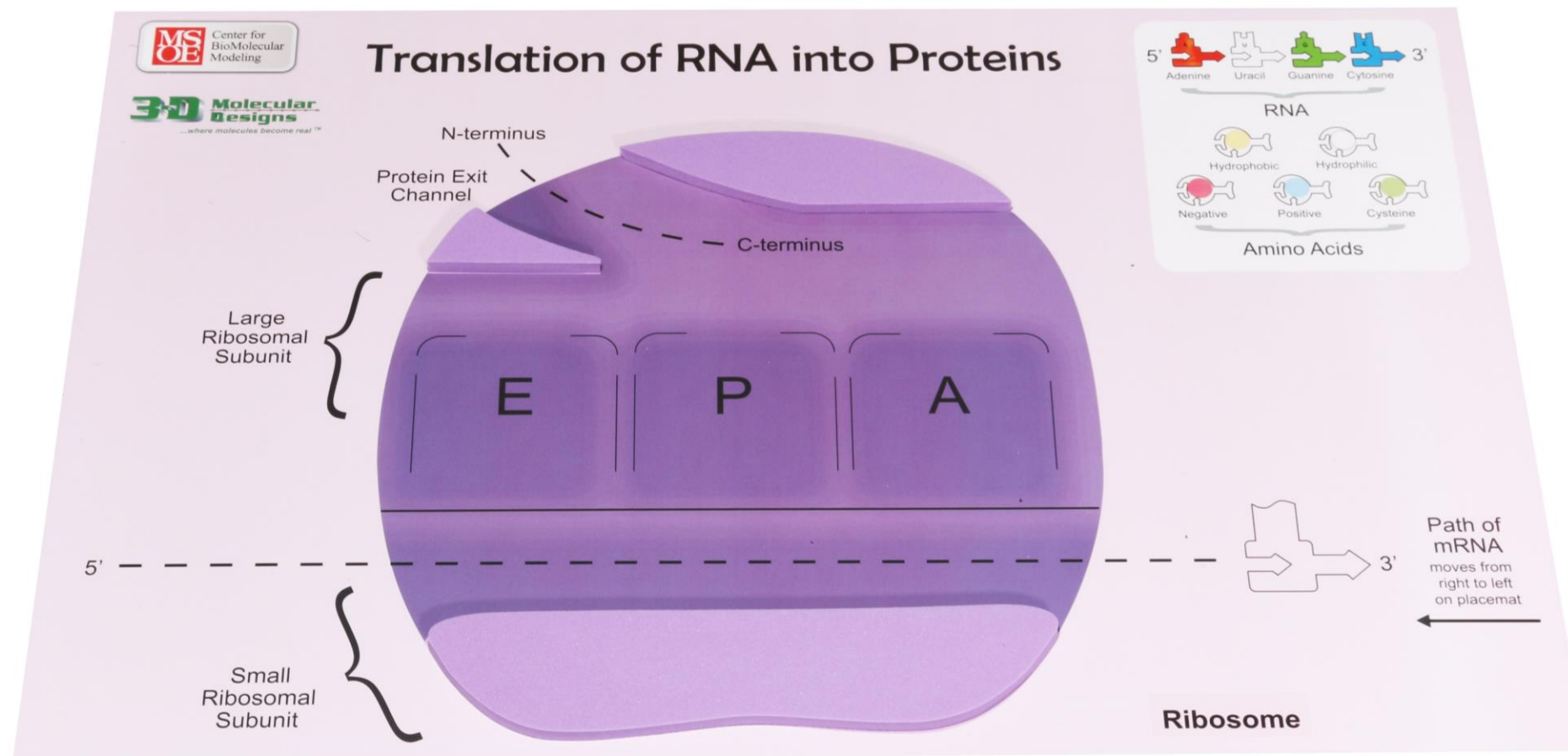
https://www.brainkart.com/article/Transcription_38062/



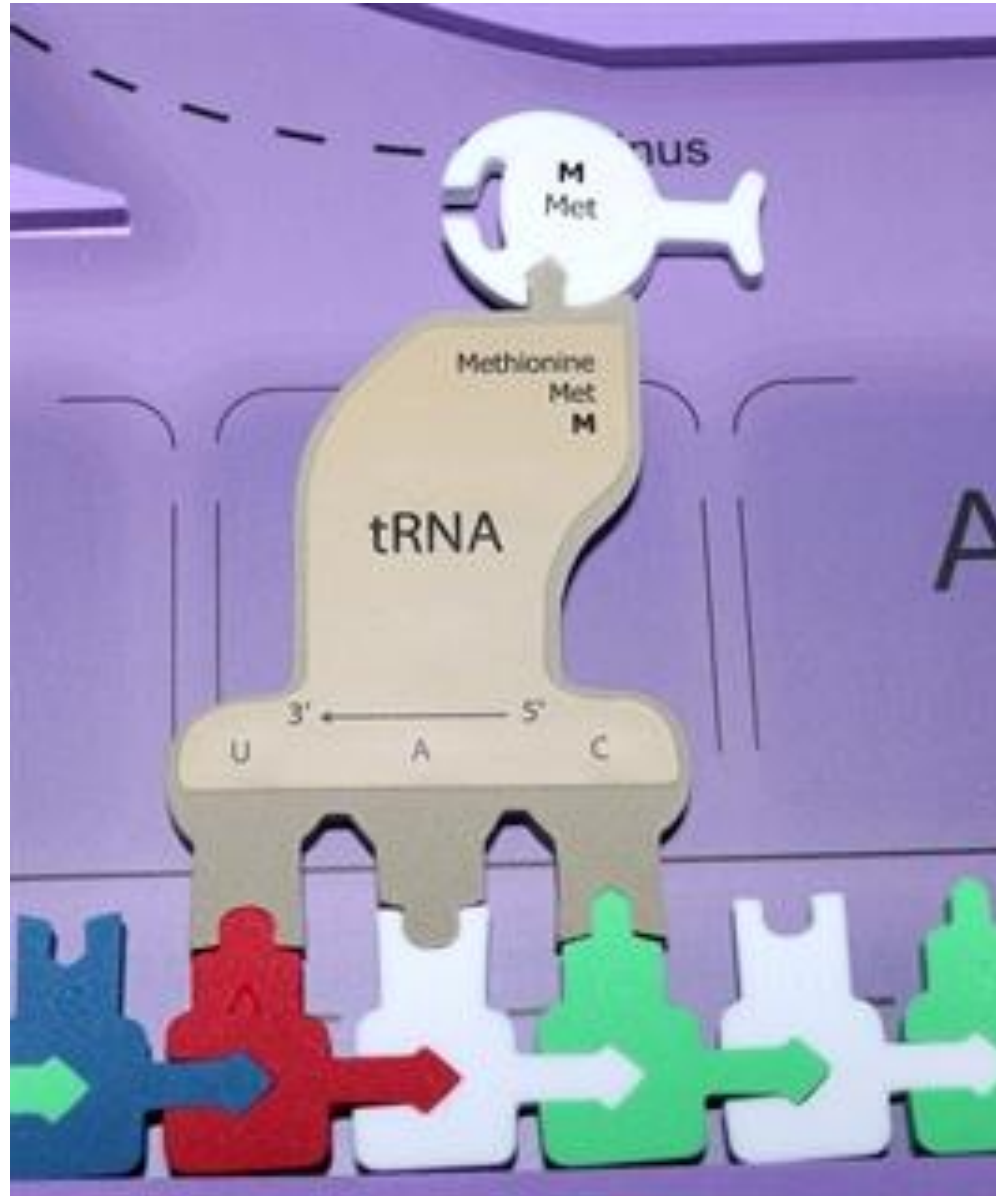
Translation



Translation Placemat ...

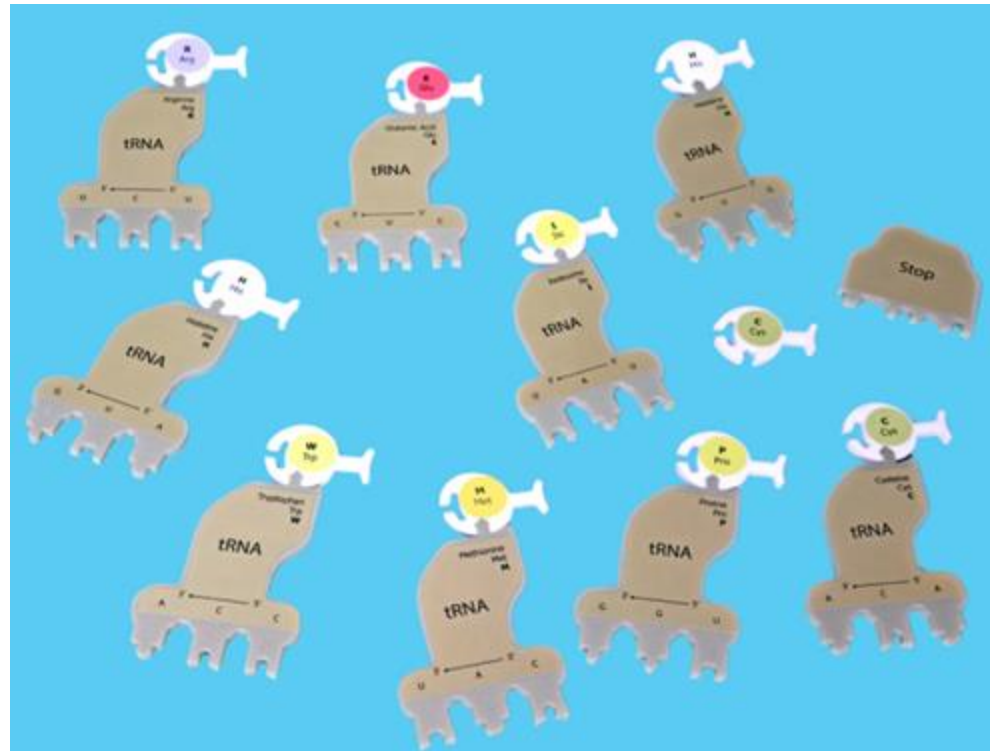


tRNA's & Amino Acids



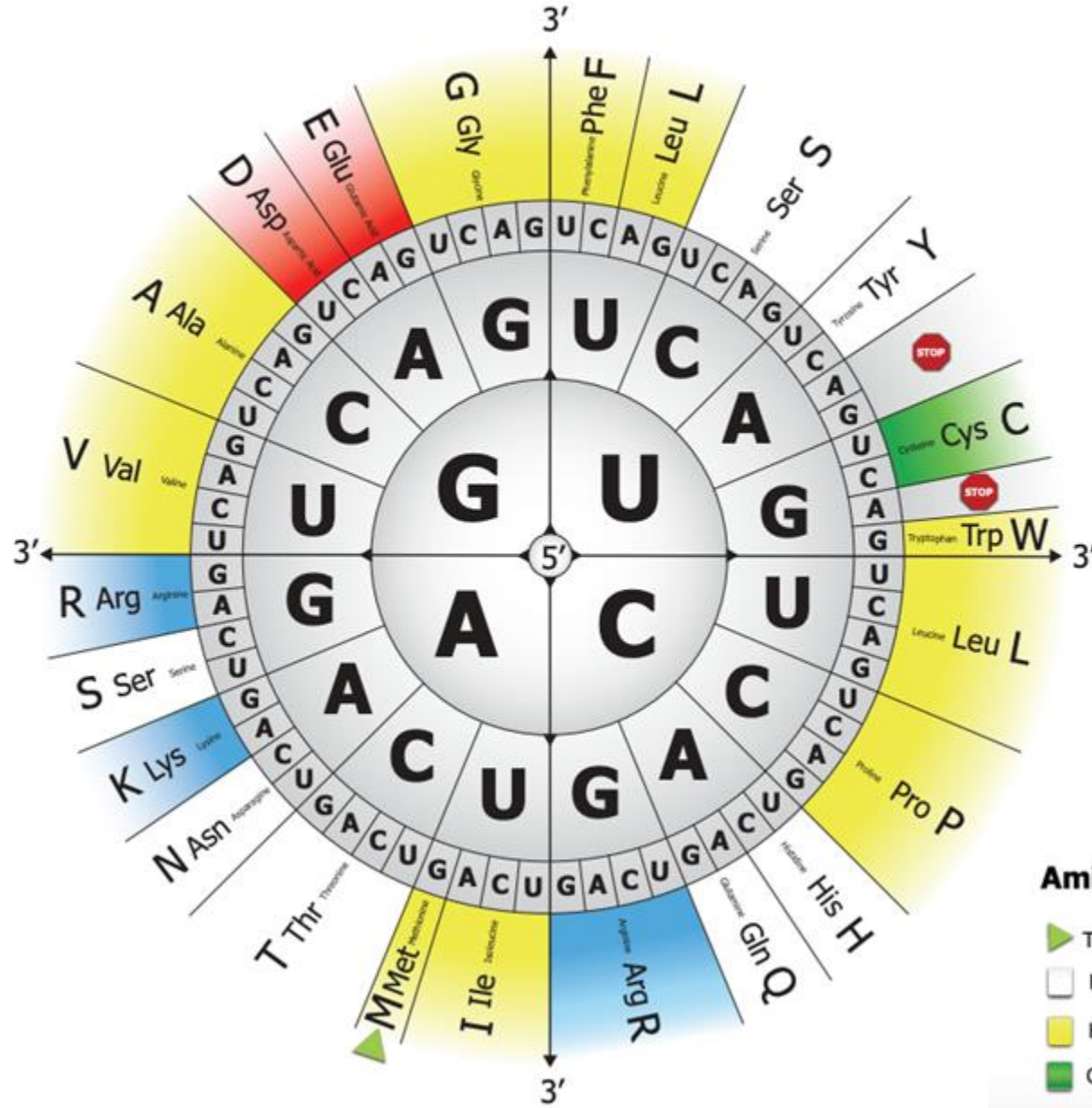
5' -----> 3'

mRNA Codons	AUG	UGU	GAG	AUA	CAU	UGG	CCA	AGA	CAC	UGU	UAG
tRNA anticodons	UAU	ACA	CUC	UUA	GUA	ACC	GGU	UCU	GUG	ACA	AUC
Amino Acid	Met	Cys	Glu	Ile	His	Trp	Pro	Arg	His	Cys	STOP





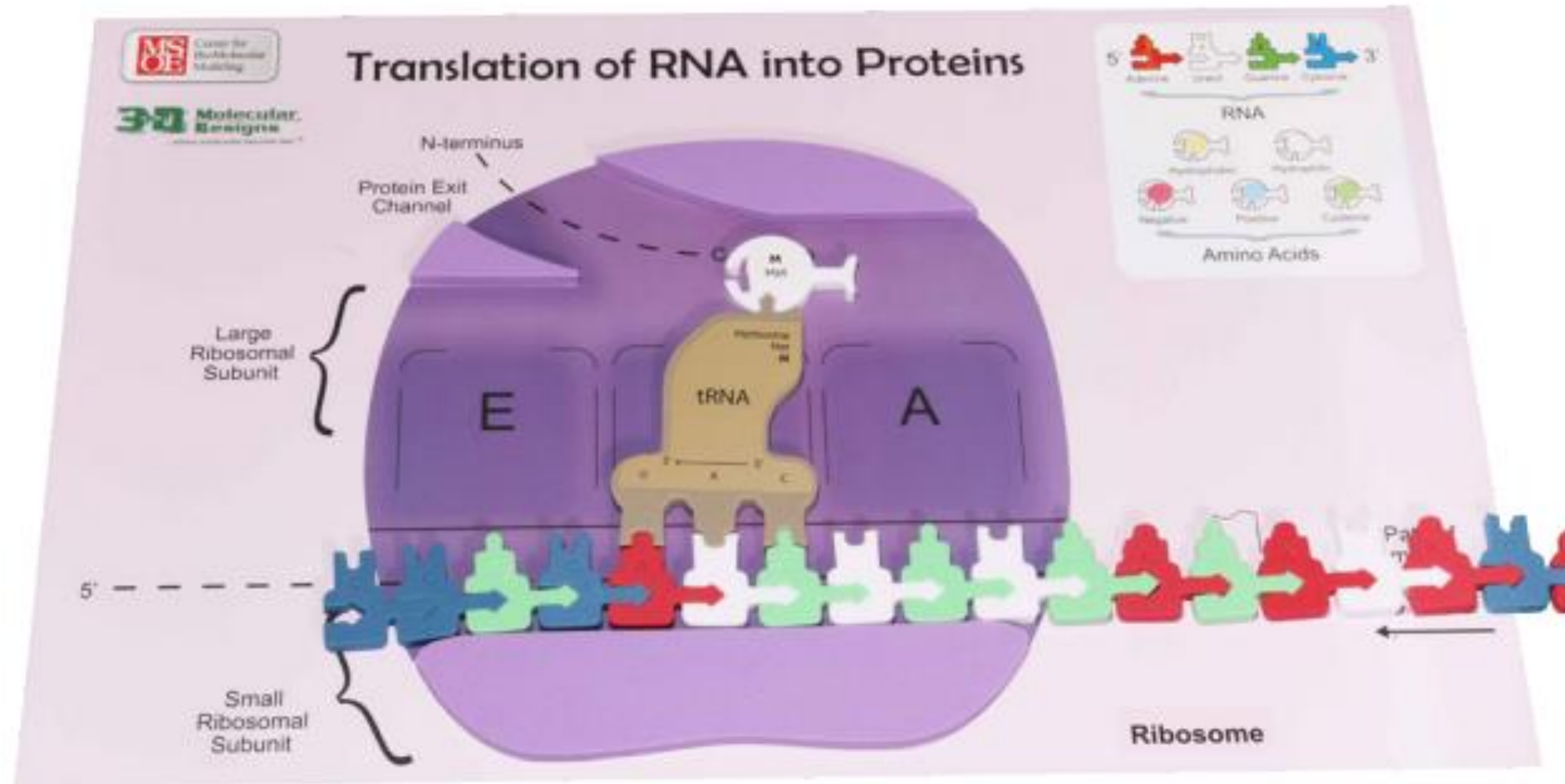
The Genetic Codon Circle[®]



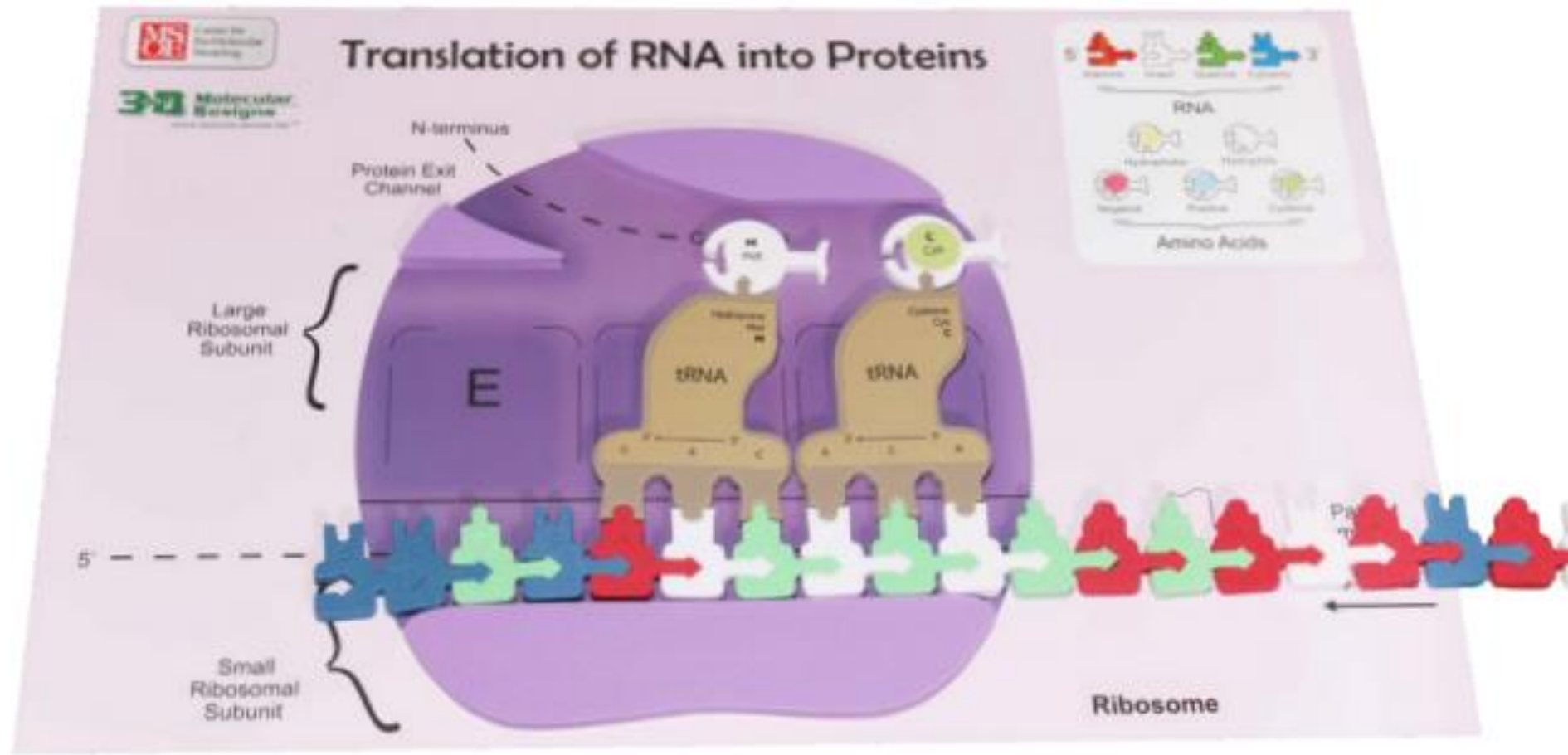
Amino Acid Properties

- Translation Start Codon (Green triangle)
- Translation Stop Codon (Red circle with STOP)
- Hydrophilic / Polar (White square)
- Negative Charge (Red square)
- Hydrophobic / Non-polar (Yellow square)
- Positive Charge (Blue square)
- Cysteine (Green square)

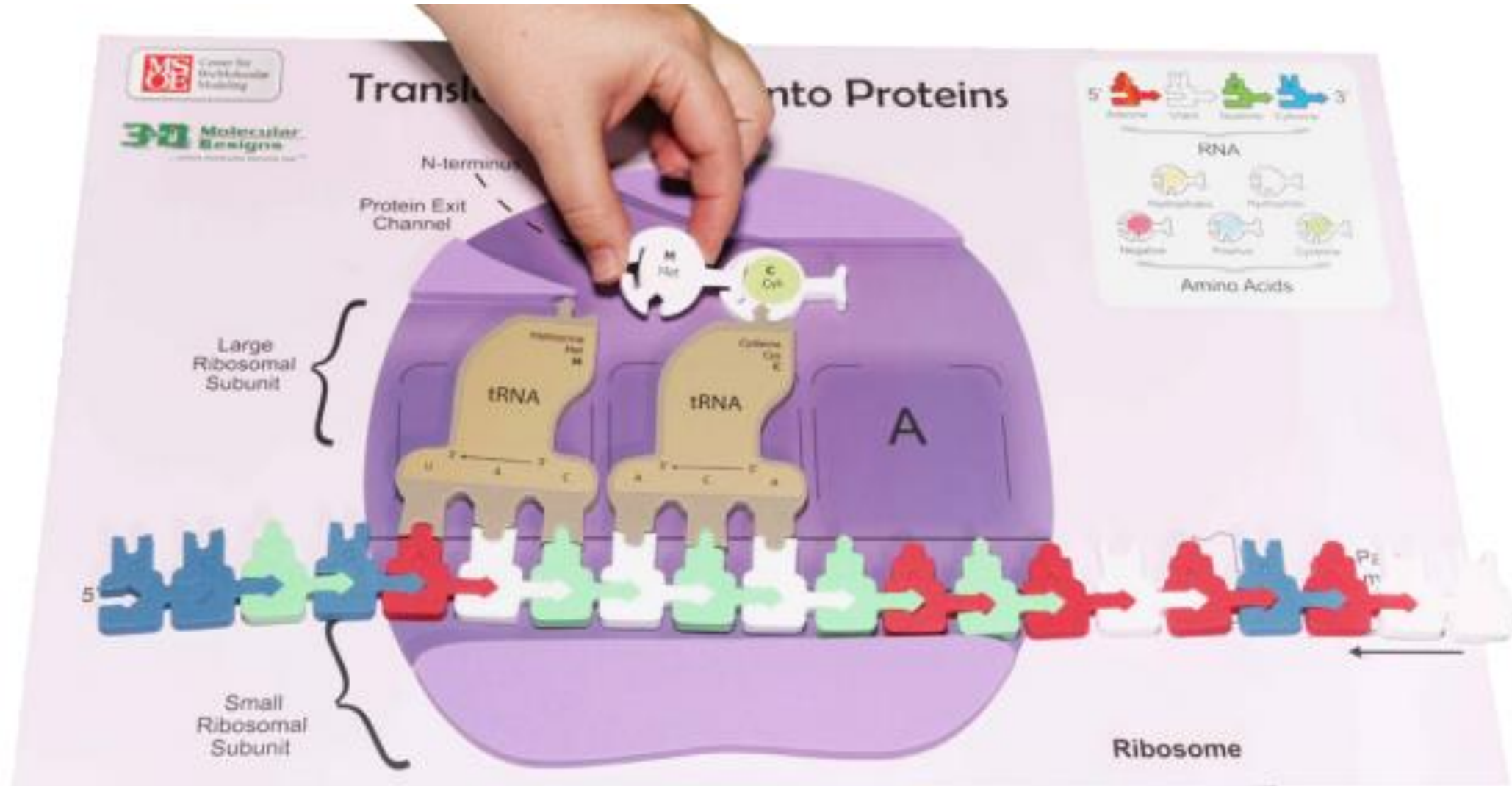
Initiation



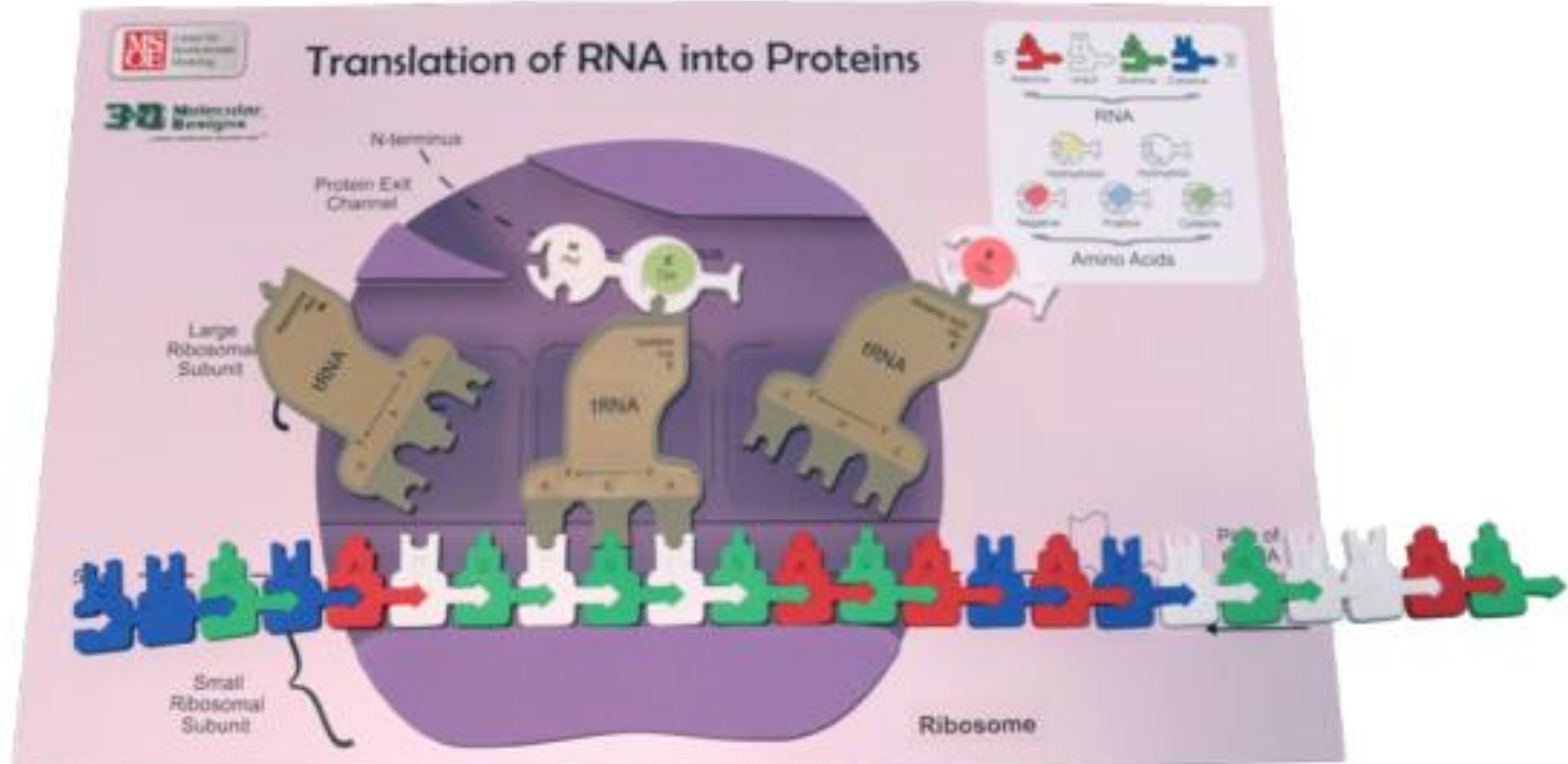
Elongation



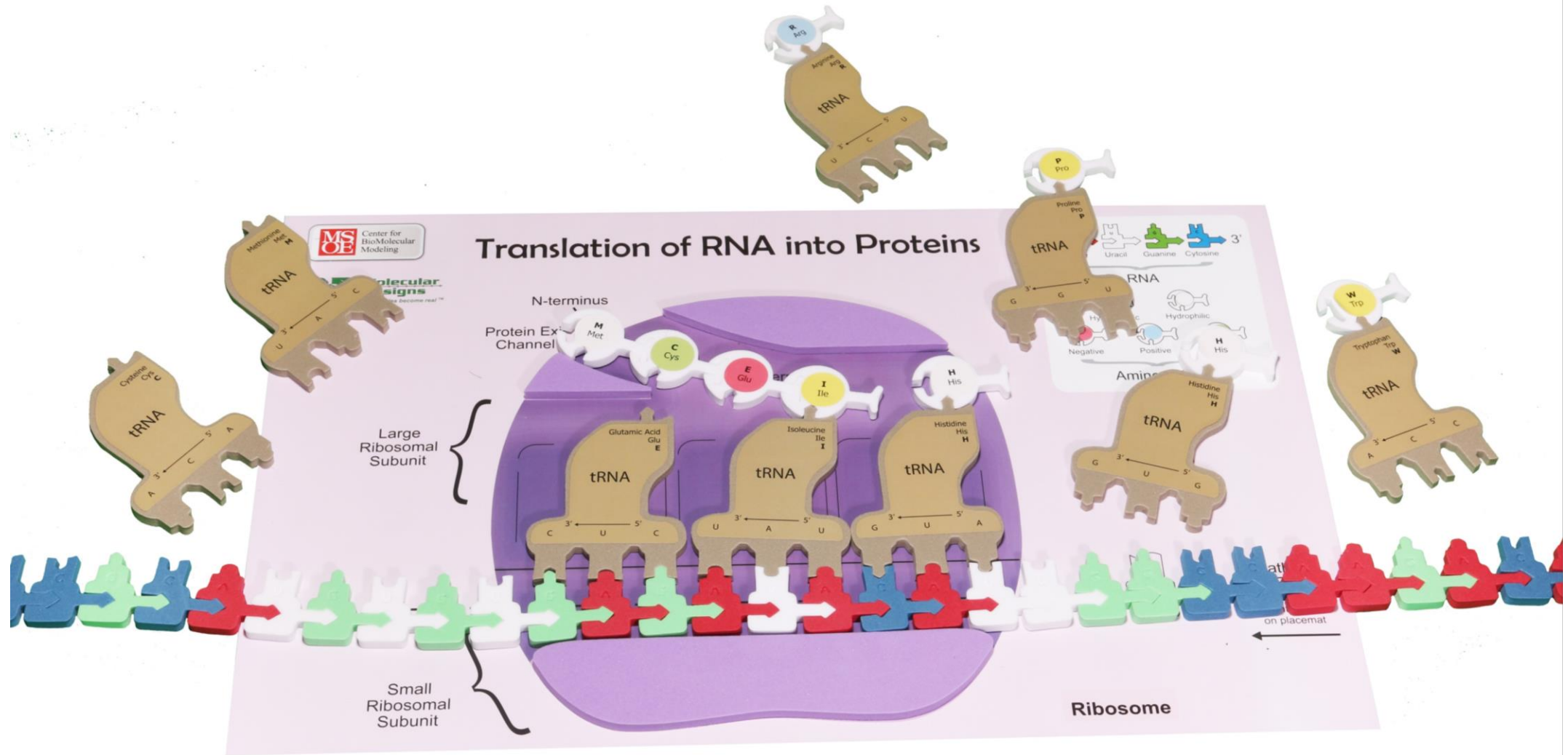
A-Site, P-Site, E-Site



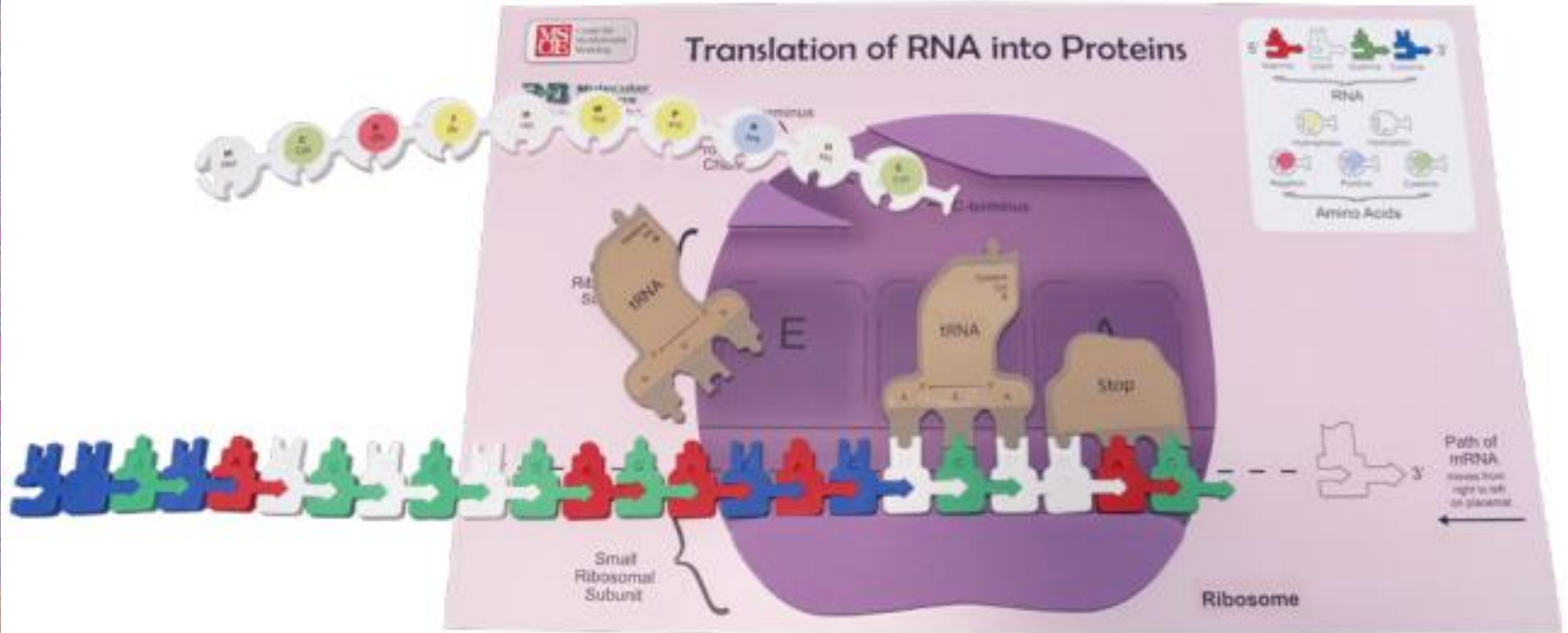
A-Site, P-Site, E-Site



Elongation Continues

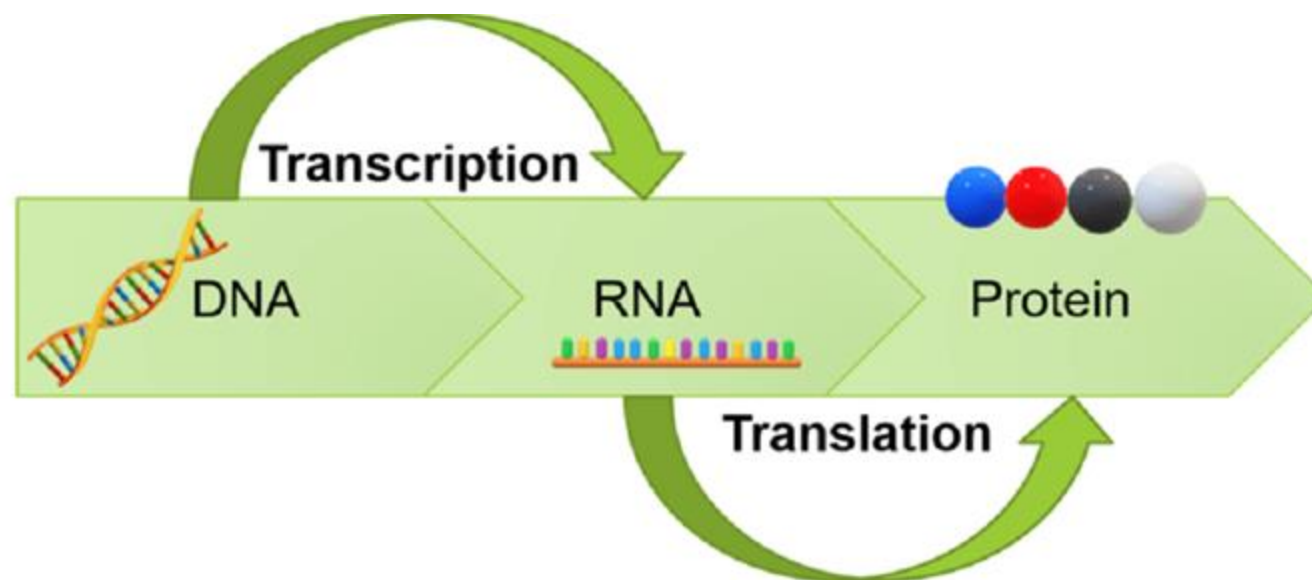


Termination

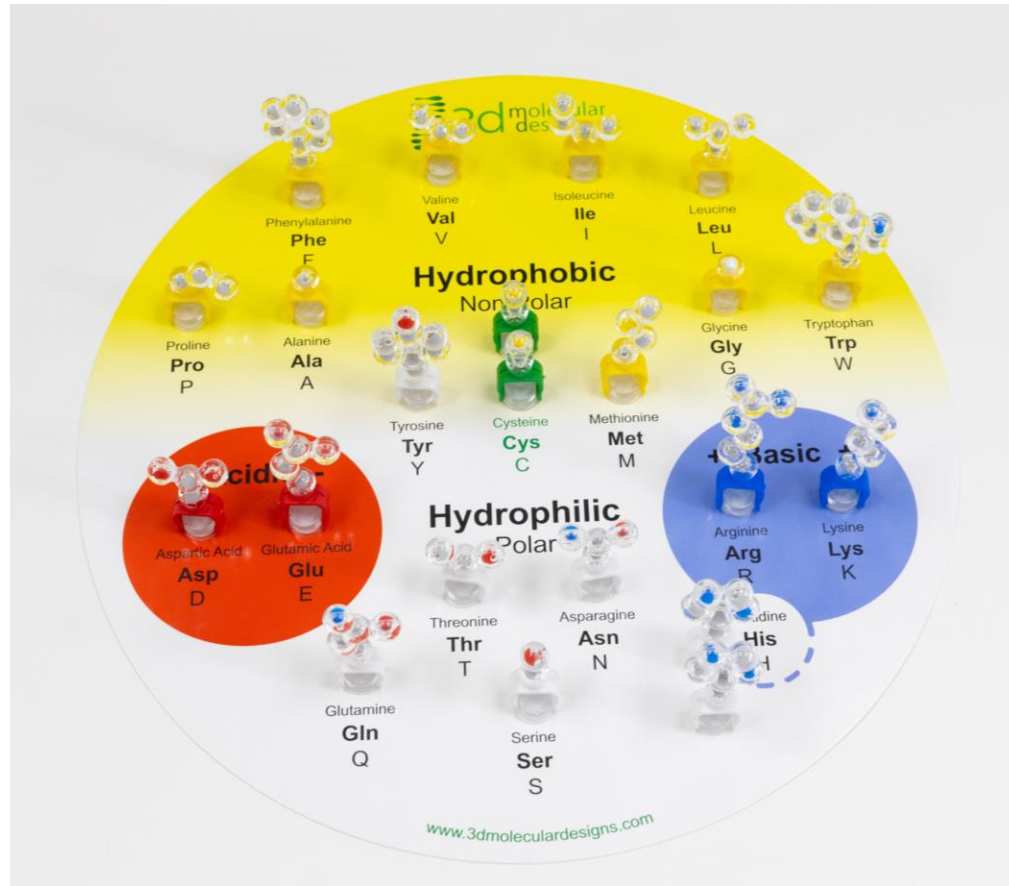




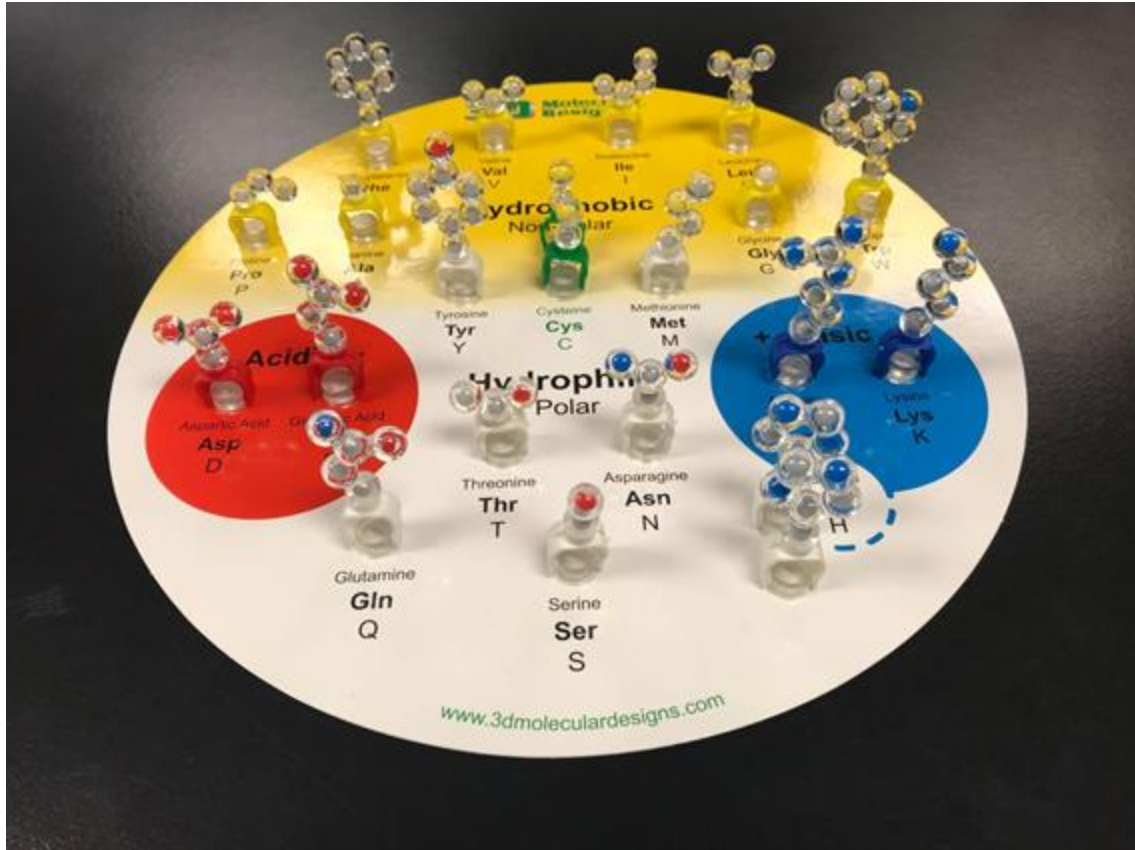
- DNA
- mRNA
- tRNA
- Polypeptide Chain

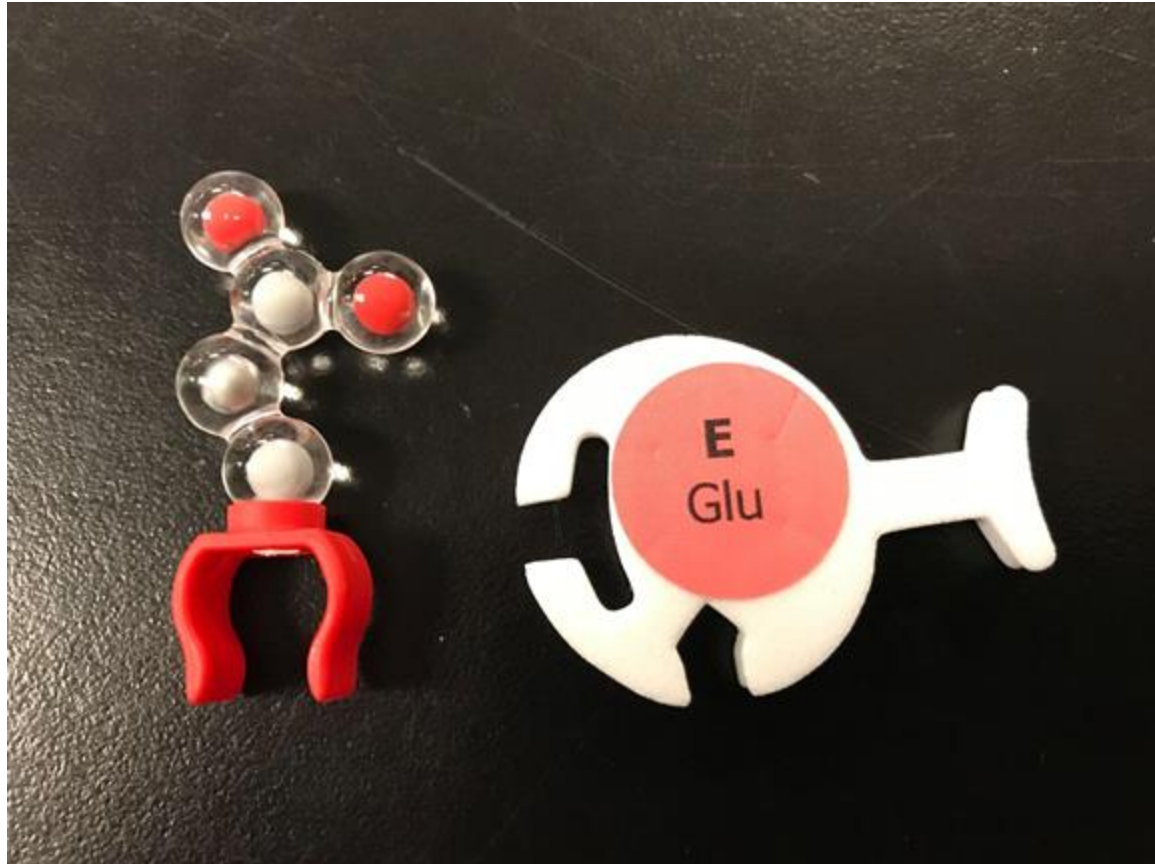


Connecting FGIK to the Amino Acid Starter Kit



Amino Acid Starter Kit Meets the FGK



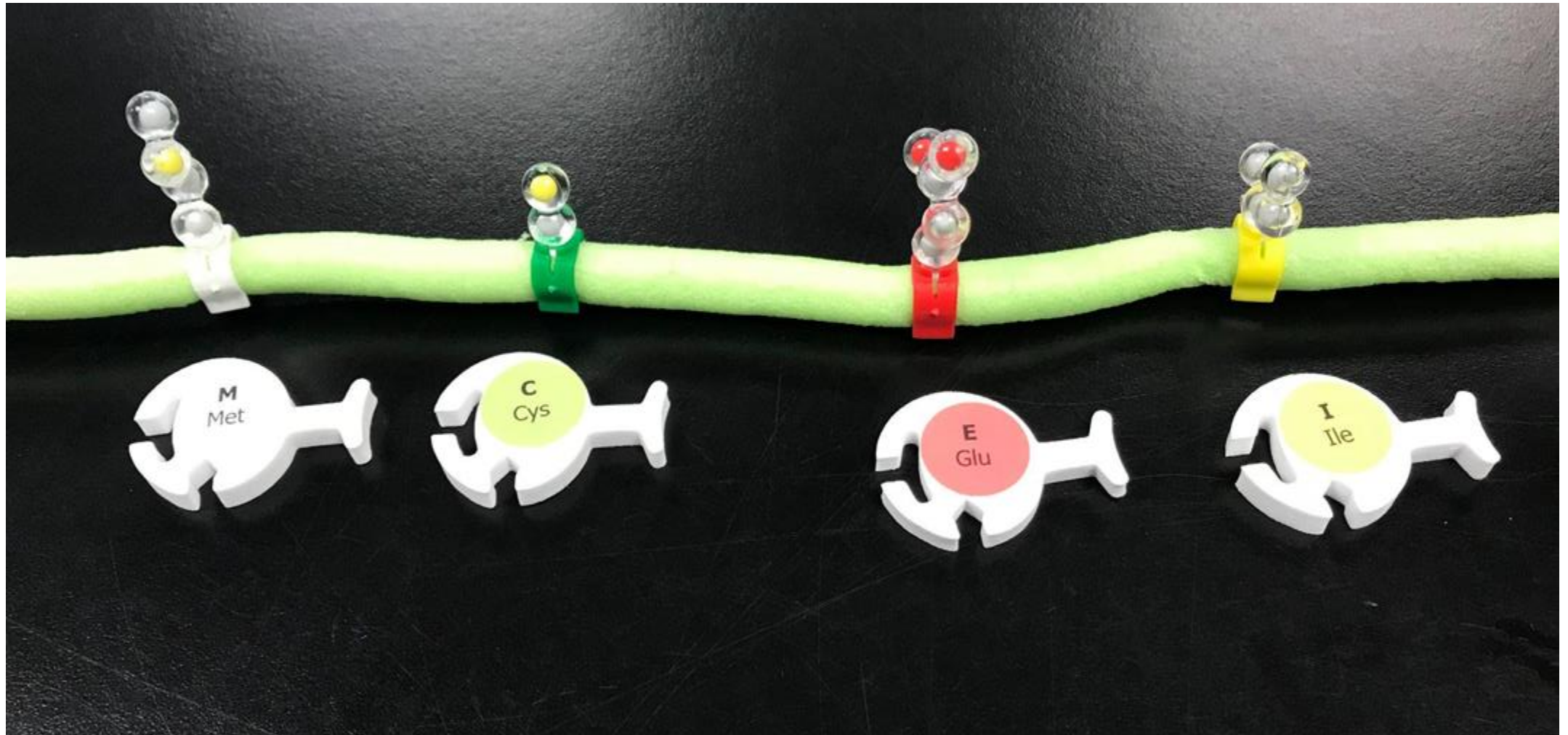




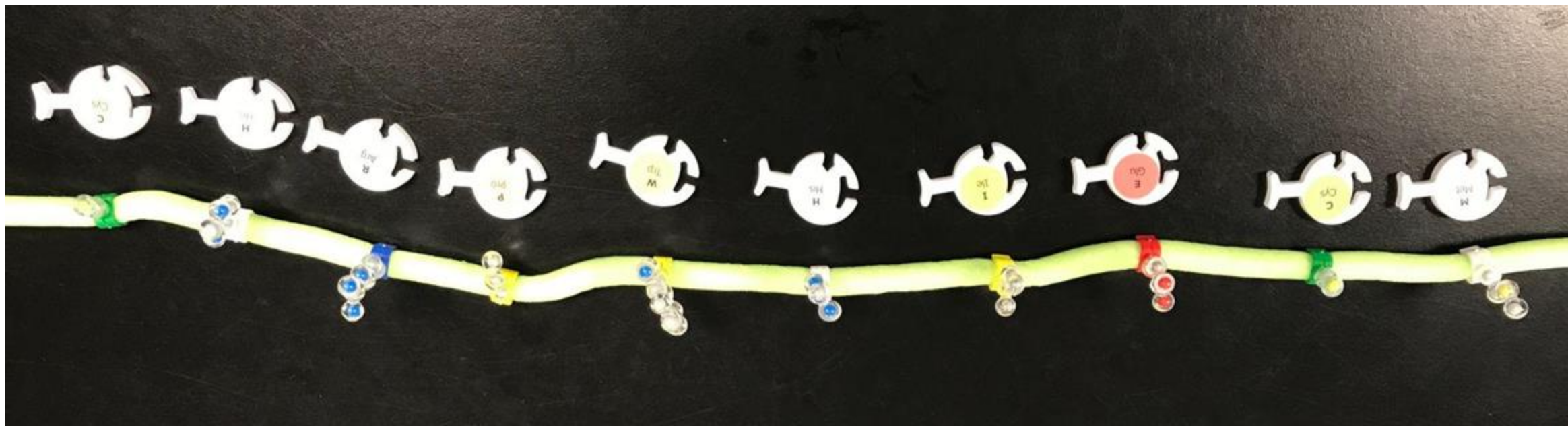
Match the 3D Amino Acids to their foam counterparts!



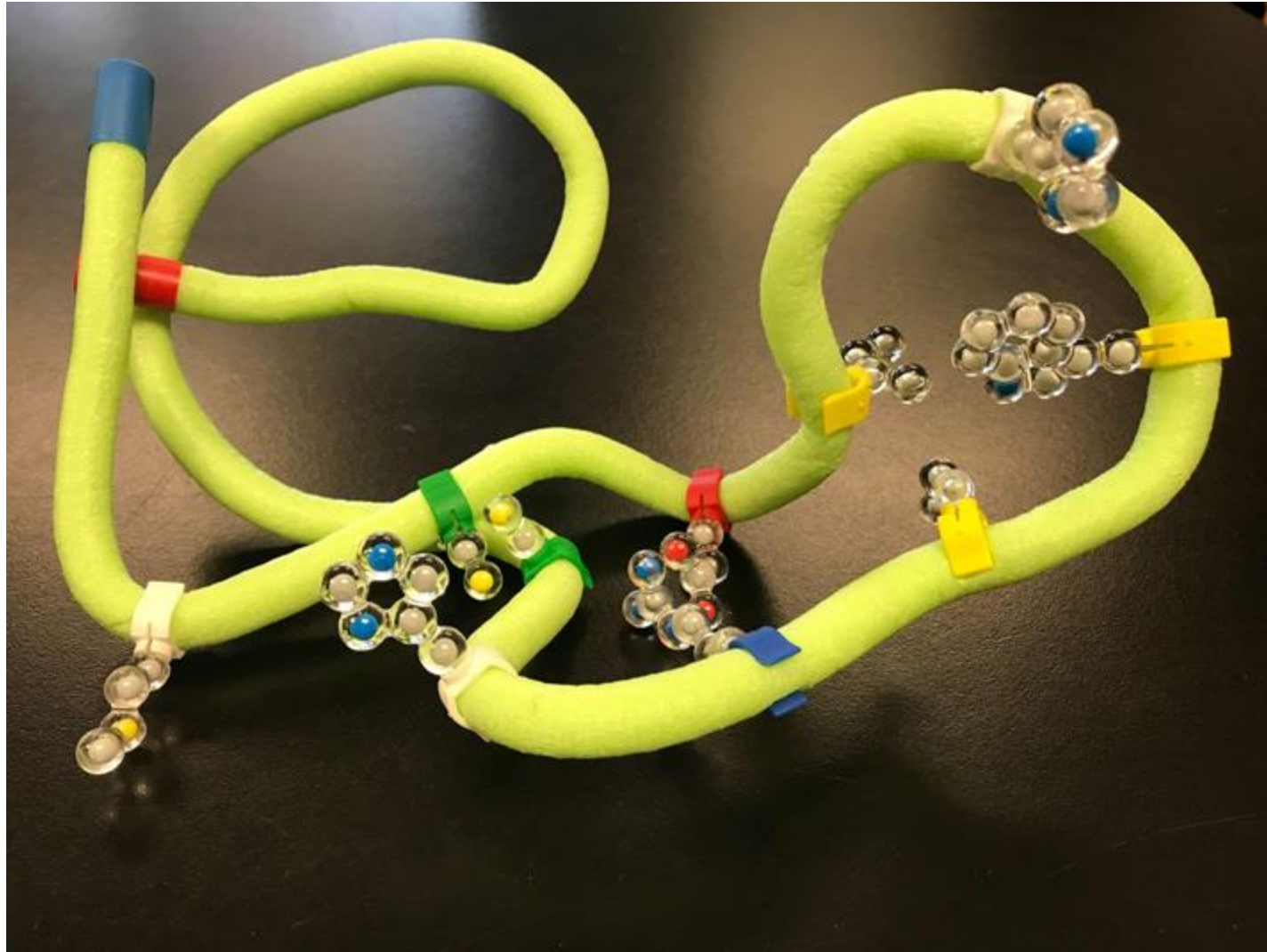
Place the Amino Acid R-groups on the Protein "Backbone"
Based on the sequence of "dictated" by the mRNA



The Complete 10 Amino Acid Sequence = Primary Structure



The Tertiary Structure of our Protein built based on our original DNA sequence!





Mutations





What happens if we add a mutation, say a base substitution, to our original DNA Strand at BP 30?



TEACHER REFLECTION

- Where in your curriculum might you be able to use these models?
- How might you adapt these models to help meet your students' needs?
- What type of support could you provide your students to help them successfully model key concepts in the life science classroom?

Link to today's presentation!



Kits and models used in this session:

Flow of Genetic Information Kit

Amino Acid Starter Kit



Purchase and Borrow Kits from
3DMolecularDesigns.com



3d molecular designs

Transforming Science Learning

