Student Guide

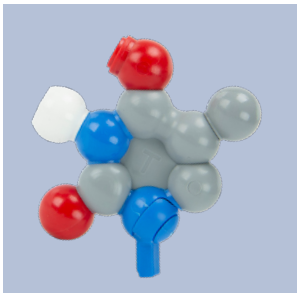
Part 3 - Modeling DNA Function: Transcription

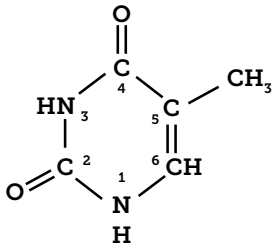
Questions to jumpstart your thinking

1. What is a protein? Why do you need them?
2. How does your body produce the proteins it needs?
3. Where is the information for making a protein stored?

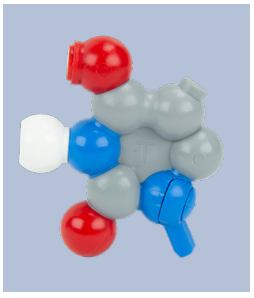
DNA stores the instructions for accurately building specific proteins but does not build these proteins directly. The bridge between DNA (**deoxyribonucleic acid**) and protein synthesis is the nucleic acid RNA (**ribonucleic acid**). Studying the structure of these important nucleic acids establishes the relationship between their biological functions.

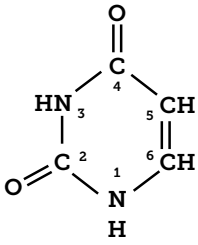
You have previously constructed the four nucleotides comprising a DNA molecule. These nucleotides can be easily converted to their RNA counterparts.





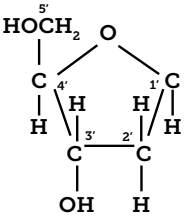
thymine (T)



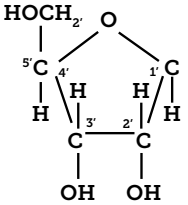


uracil (U)

To convert the DNA nucleotides **adenine**, **guanine** and **cytosine** to RNA nucleotides, add an oxygen cap to the 2' carbon of the sugar.



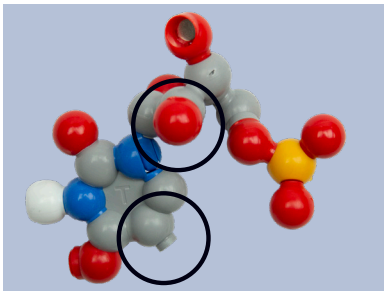
deoxyribose



ribose

The nitrogen base thymine found in DNA is replaced by the nitrogen base **uracil** in RNA. To convert thymine to uracil you will need to add an oxygen cap to the 2' carbon of the sugar AND remove the carbon atom from the carbon in the 5th position in the thymine ring.

Answer PART 3 questions 1-4 on the student answer sheet.



uracil

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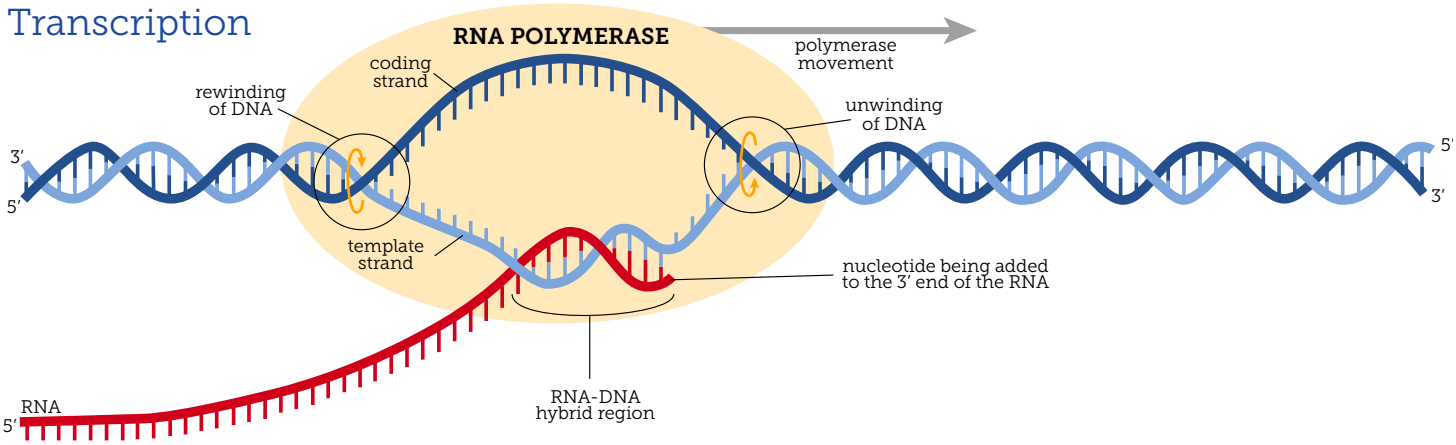
Transcription is the cellular process by which DNA is used as a template to produce a single-stranded RNA molecule identified as messenger RNA (mRNA). The DNA code now contained in the mRNA is deciphered into a sequence of linked amino acids in a process known as **translation**. This linear sequence of amino acids is folded into a complex 3-dimensional shape following the basic principles of chemistry and physics.

In eukaryotic cells, DNA is found in the nucleus, chloroplasts and mitochondria, and cannot leave these structures. As a result, transcription occurs within these organelles.

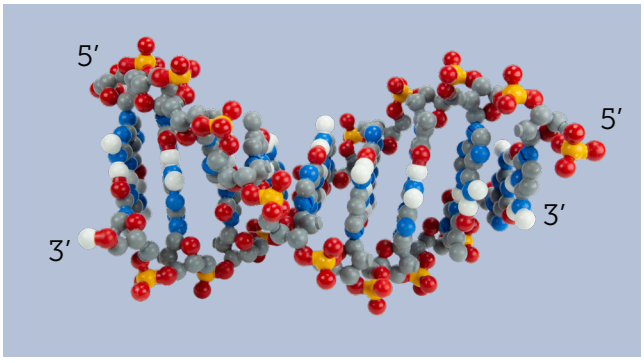


Answer PART 3 question 5-6 on the student answer sheet.

In this next modeling exercise, you will use the 12 base pair set of *Dynamic DNA*© to simulate a streamlined process of 3-dimensional RNA transcription.

1. **Assemble** 9 DNA base pairs to form a double helix with the following suggested DNA sequence:

5′	**C**	**A**	**T**	**G**	**C**	**A**	**T**	**G**	**C**	3′	Template
5′	**G**	**T**	**A**	**C**	**G**	**T**	**A**	**C**	**G**	3′	Nontemplate



2. **Convert** the remaining two adenine (A) nucleotides, one guanine (G) nucleotide, one cytosine (C) nucleotide and two thymine (T) nucleotides into the corresponding RNA nucleotides.

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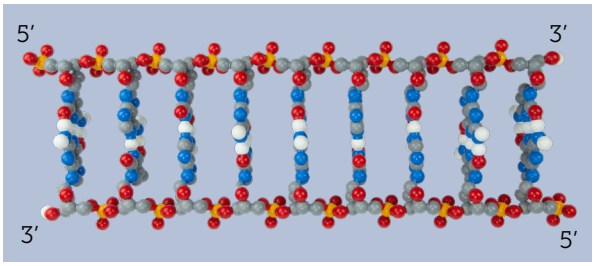
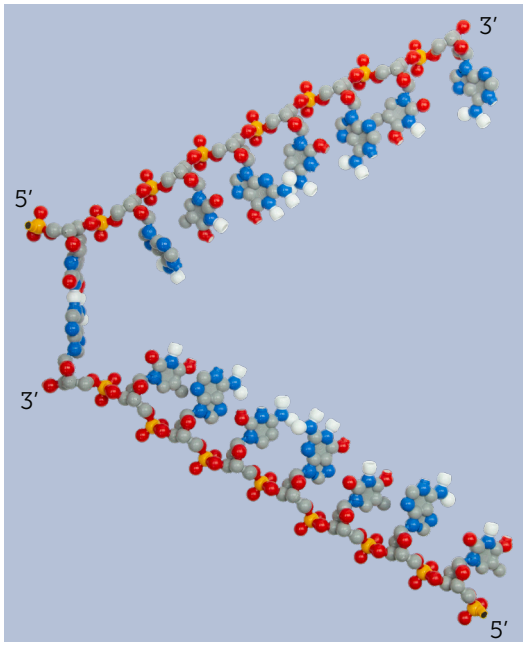
In eukaryotes, initiation of transcription begins with a collection of proteins called transcription factors, which facilitate the binding of the enzyme **RNA polymerase** to the DNA. These signals encoded in the DNA tell RNA polymerase where to start and where to finish. The start and stop signals are NOT included in this simplified model of transcription.

RNA polymerase untwists the double helix, exposing 10-20 DNA nucleotides at a time for pairing with RNA nucleotides.

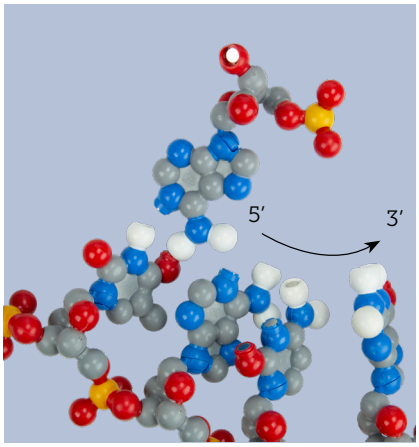


3. Begin the process by **untwisting** the 9 base pair DNA double helix you have previously constructed.



4. **Separate** the two strands, keeping the first base pair together.

Answer PART 3 question 7 on the student answer sheet.



5. Like DNA polymerases that function in DNA replication, RNA polymerases assemble mRNA only in the 5' → 3' direction. The start codon for the mRNA used in this model is AUG. **Determine** which strand of your DNA is the template strand.

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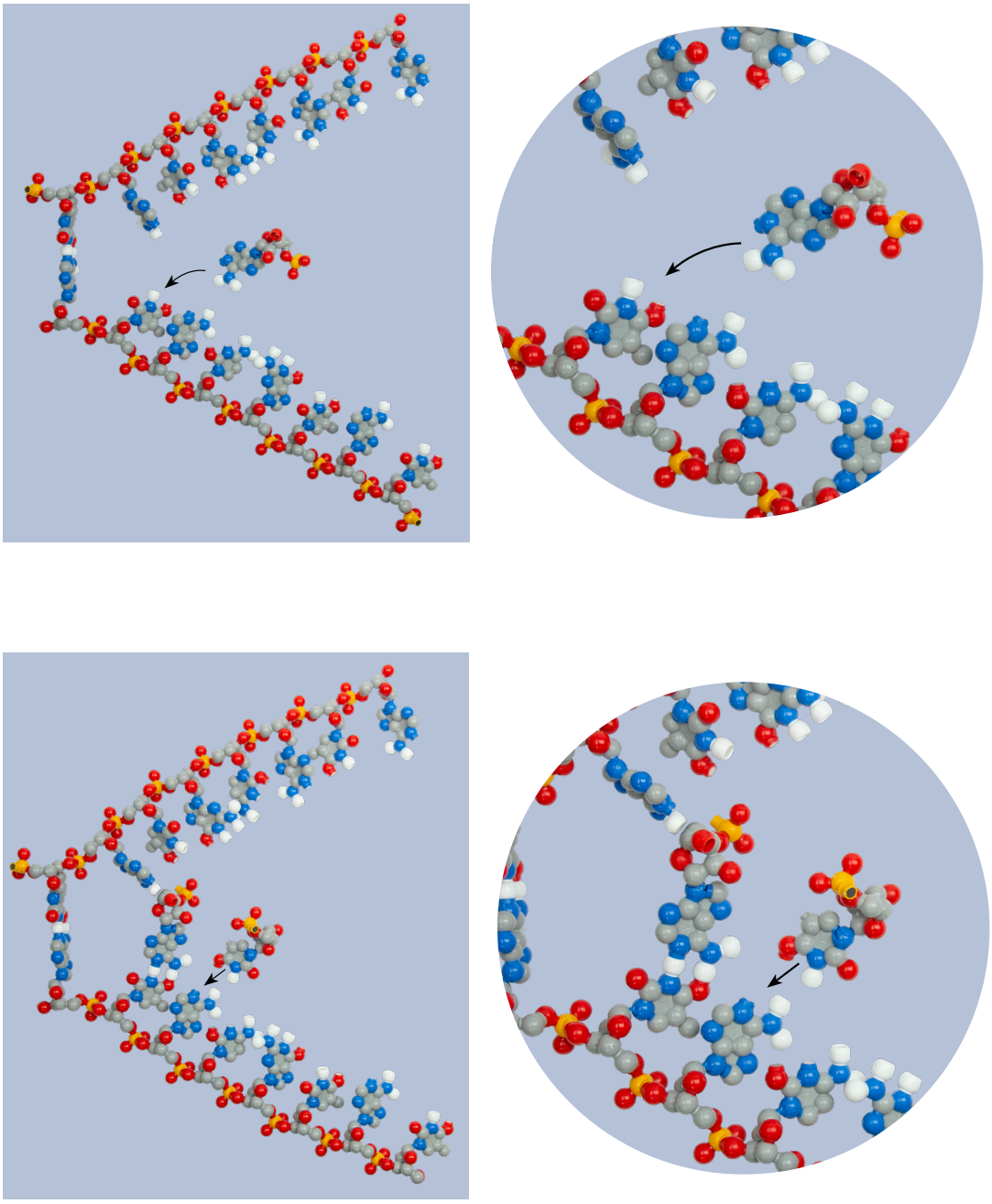
6. Continue binding the complementary RNA nucleotides to form a 6 base mRNA molecule.



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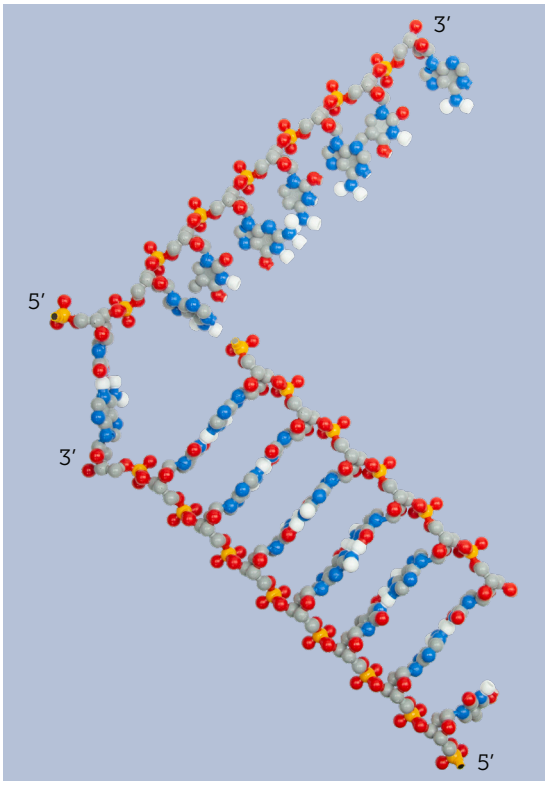
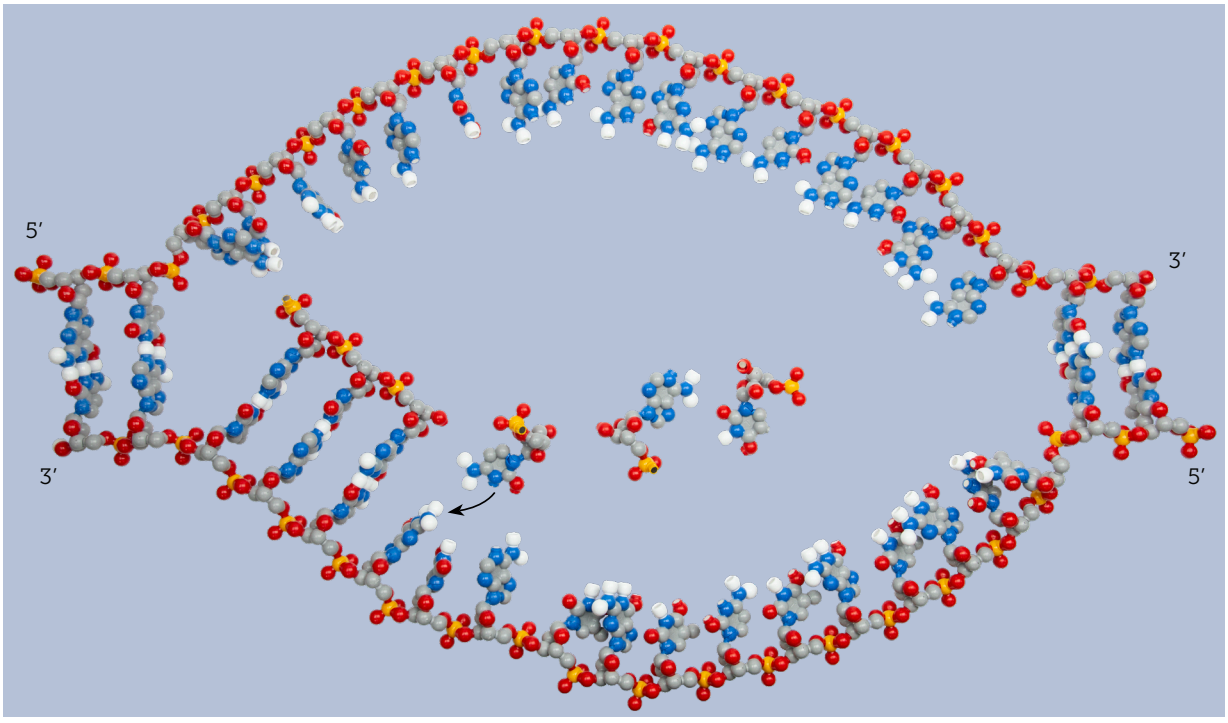


Answer PART 3 questions 8-10 on the student answer sheet.

If 3 or more *Dynamic DNA Kits*© are available, you can create a bubble to model transcription.



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