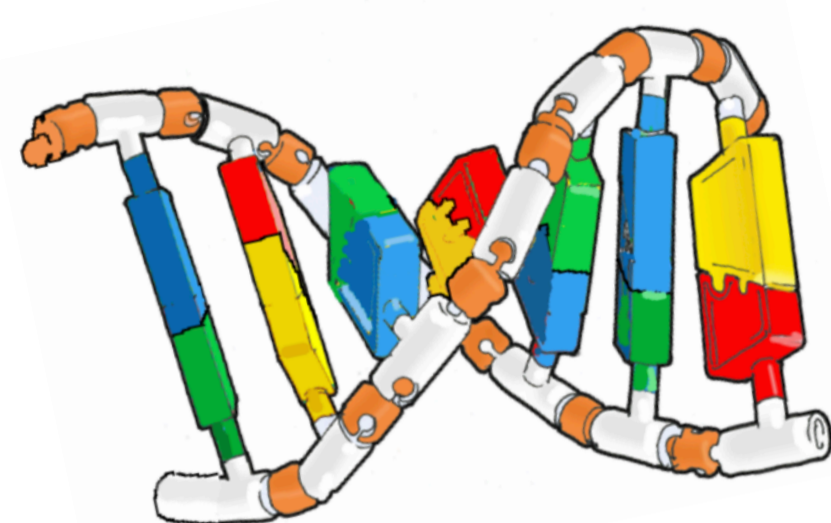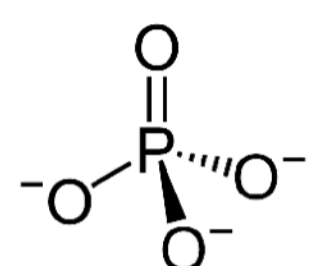# PlayDNA!

Assembly Instructions

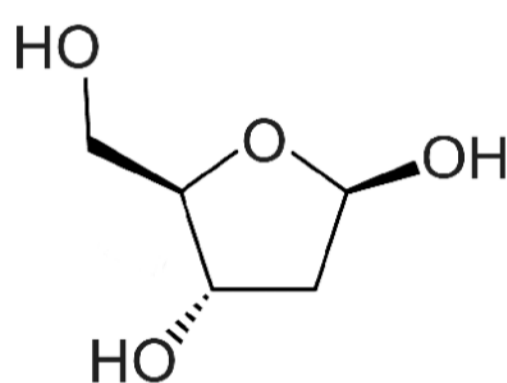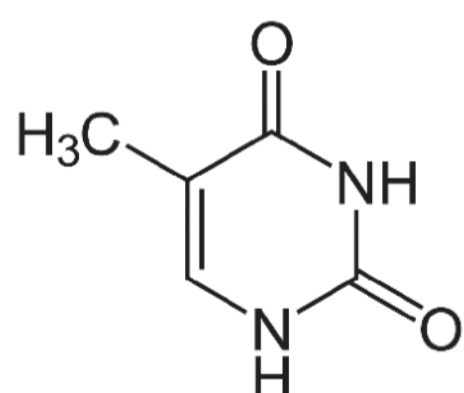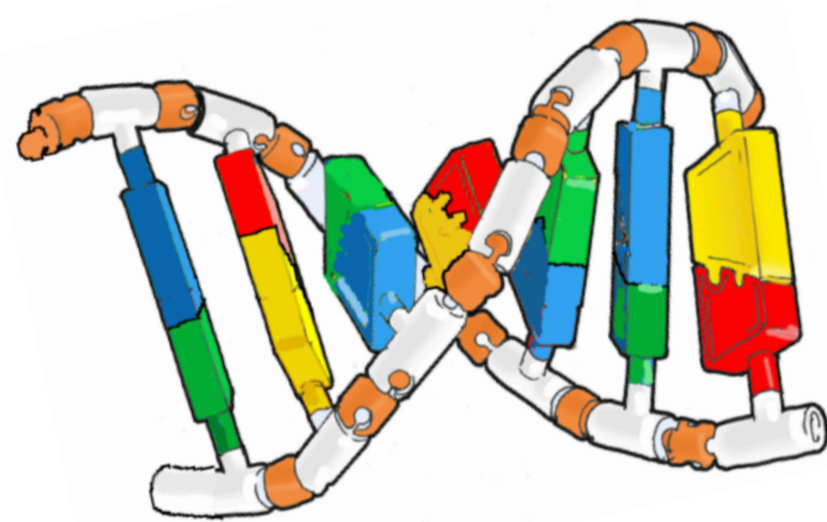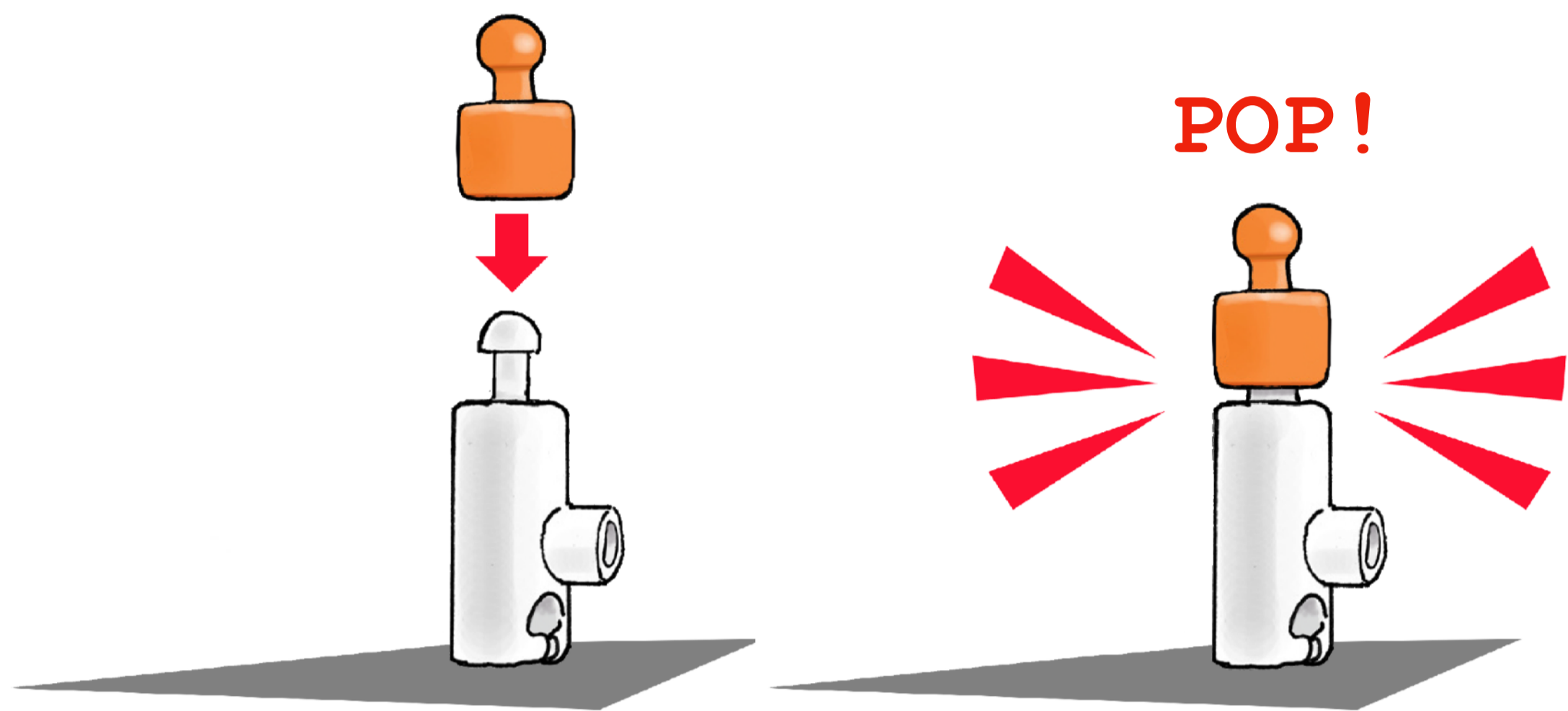| Six molecular parts of NUCLEOTIDES in DNA	...represented by six model parts:
Phosphate	PHOSPHATE ION (PO$_4$)
and	
DNA sugar (Deoxyribose)	(just a simple carbohydrate)
and	
Thymine base	THYMINE ('T')
OR	
Cytosine base	CYTOSINE ('C')
OR	
Adenine base	ADENINE ('A')
OR	
Guanine base	GUANINE ('G')
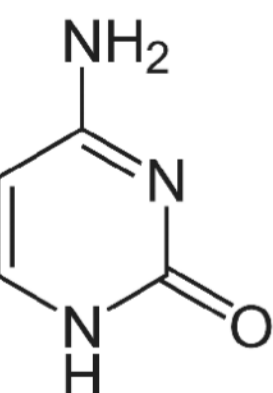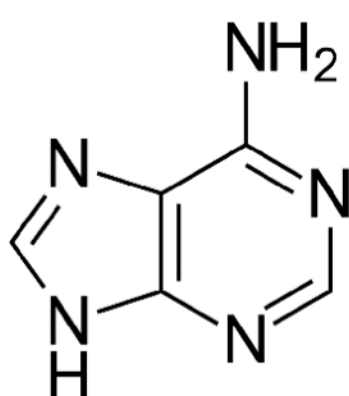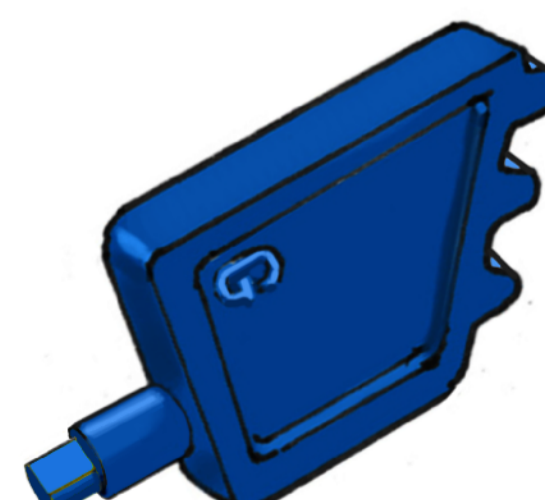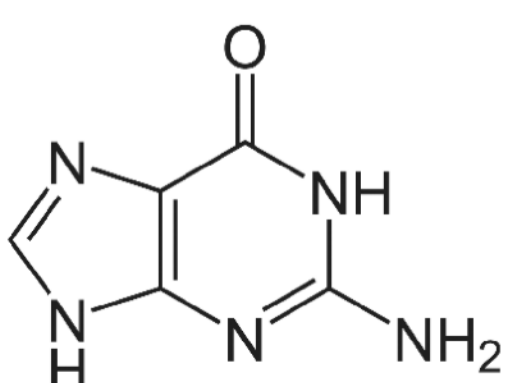
PlayDNA!

Assembly Instructions

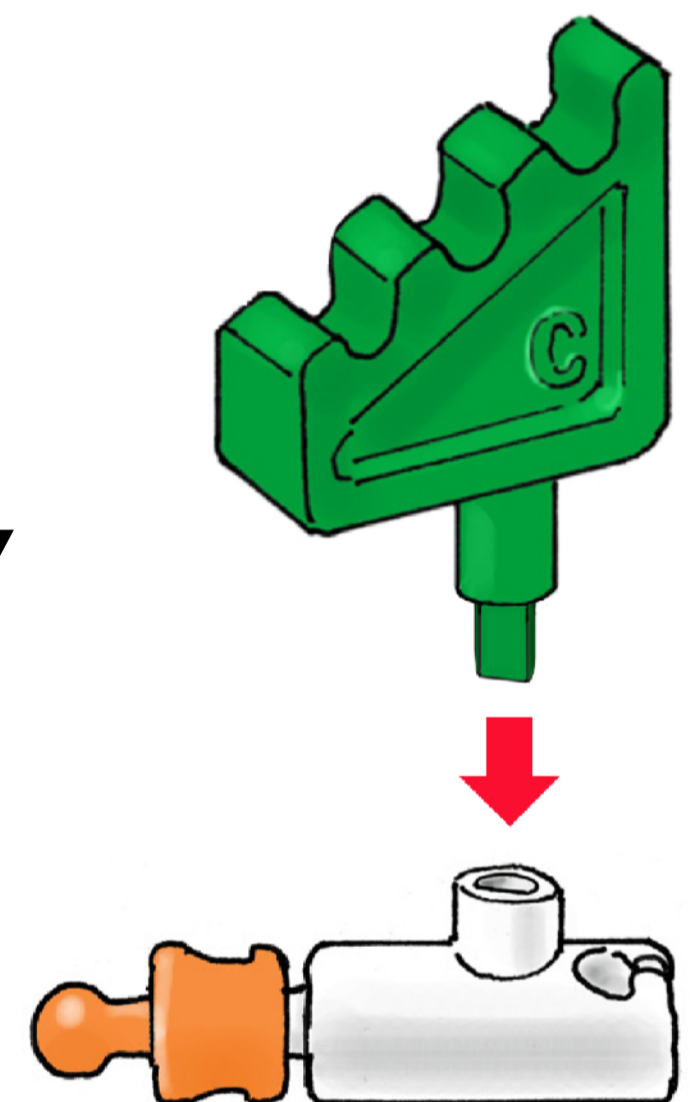---

TO BUILD A NUCLEOTIDE:
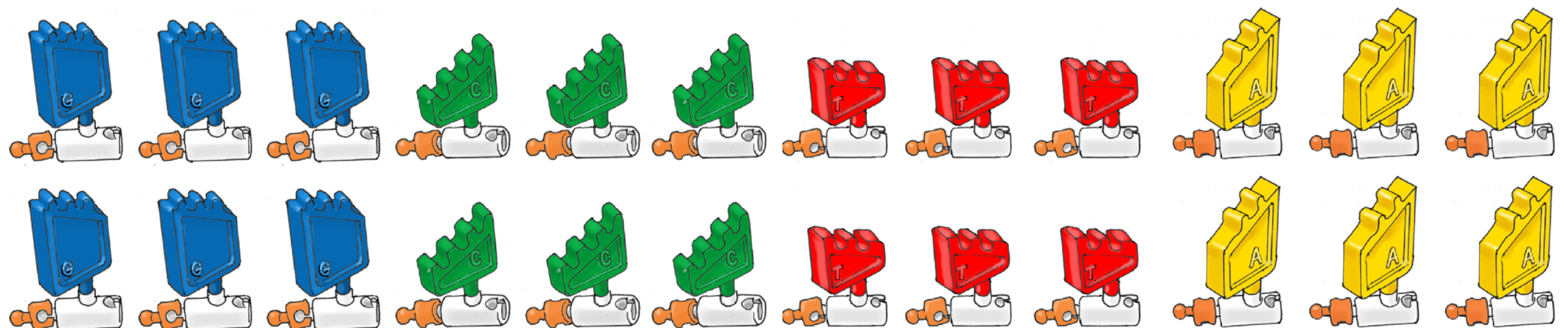
1. Push PHOSPHATE
onto SUGAR…

POP!

(It helps if you push against a tabletop.)

2. Align peg of BASE with socket of sugar,
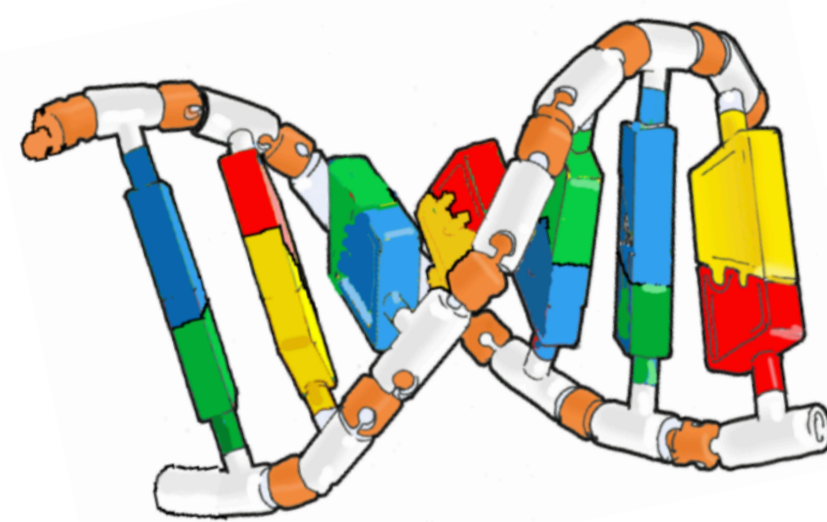and push them together hard!

(This also can be helped by a tabletop.)
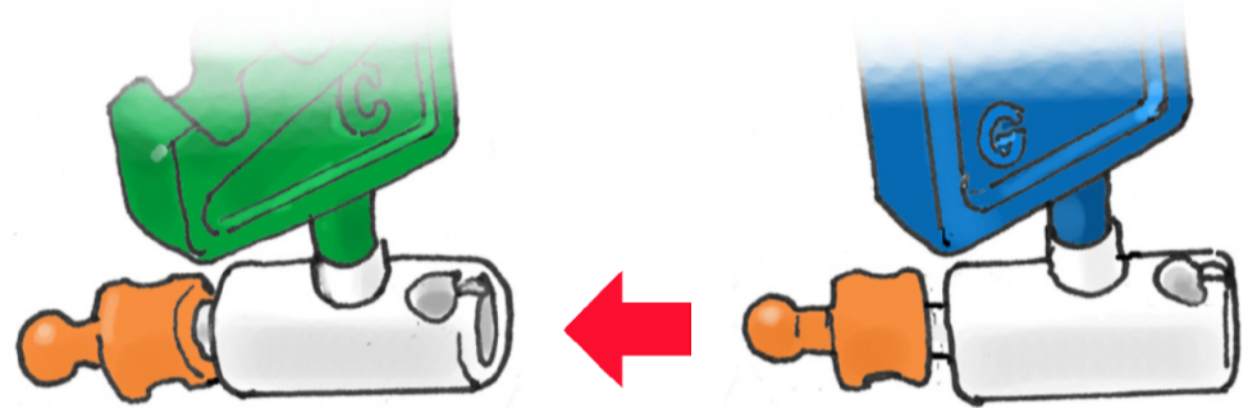
Do this again and again, until you have
built all the nucleotides…

Look at a model nucleotide. It has **asymmetry:** two ends are different. We can name them:

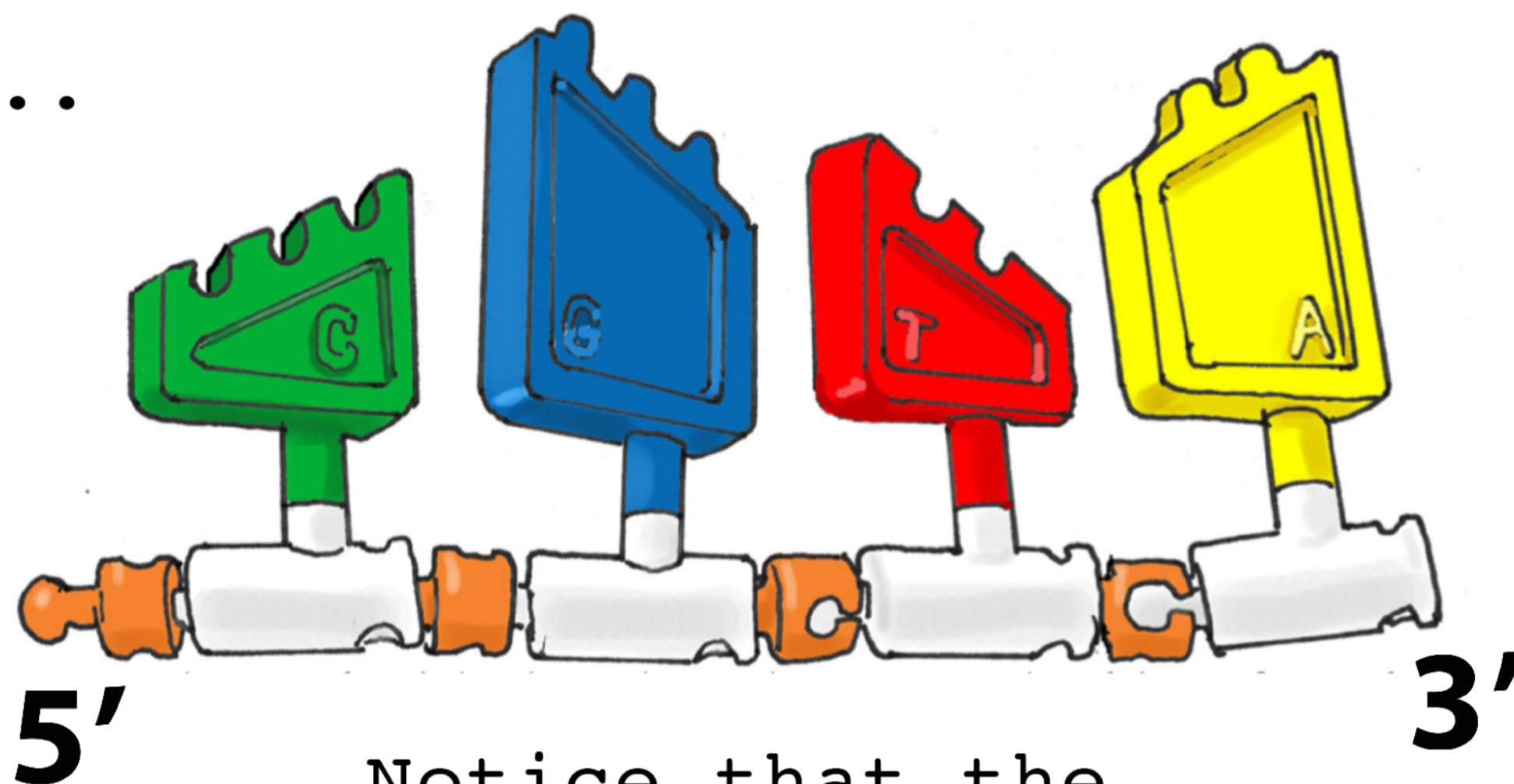The five-prime (5') end has a phosphate.

5'

3'

The three-prime (3') end has none.

A **DNA strand** is built by plugging in the 5' phosphate-end of one nucleotide to the 3' sugar-end of another...

...and so on...

**5'**   **3'**

Notice that the whole DNA strand has the same (5'-3') asymmetry.

This is a **DNA sequence**, reading 5'-CGTA-3'.

Why call these ends 5' and 3' ??

Atoms of the same kind, occupying unique positions in a molecule, need some kind of identification number for reference. In a nucleotide, the atoms in the BASE get numbered first... then atoms in the sugar get numbers, with 'prime' to distinguish them from the atoms of the base.
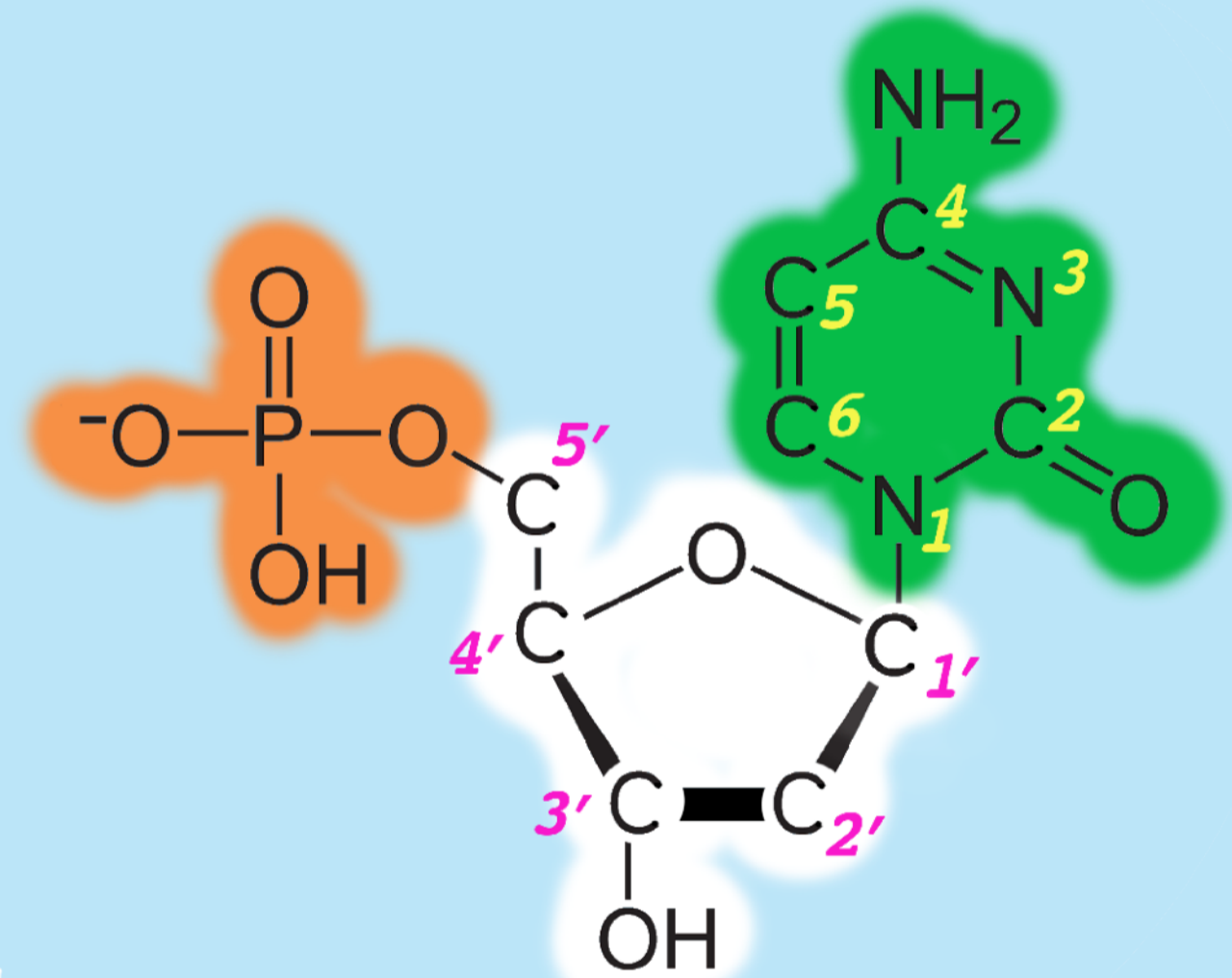
A nucleotide's base is always attached to the 1' carbon of the sugar. The phosphate is attached to the 5' carbon. And the reactive -OH on the 3' carbon is where the phosphate of another nucleotide can 'plug in.'
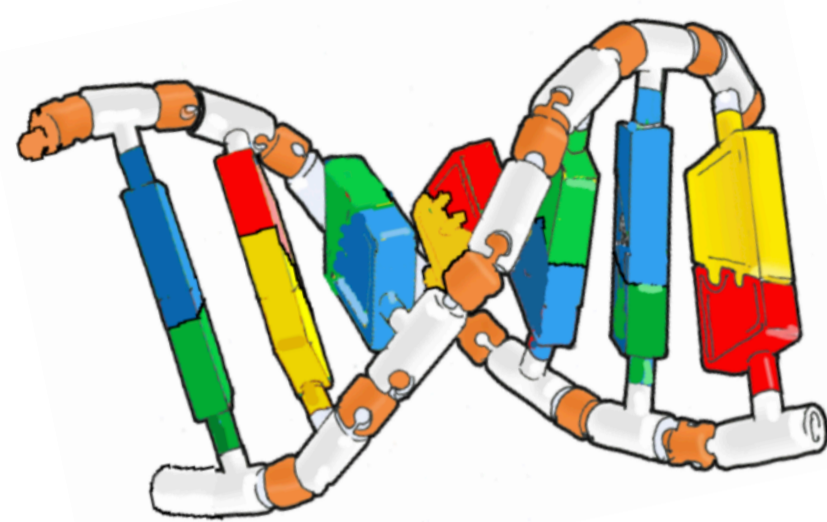
Assembly Instructions

FORMING THE DOUBLE HELIX.
I. Complementary Base Pairing

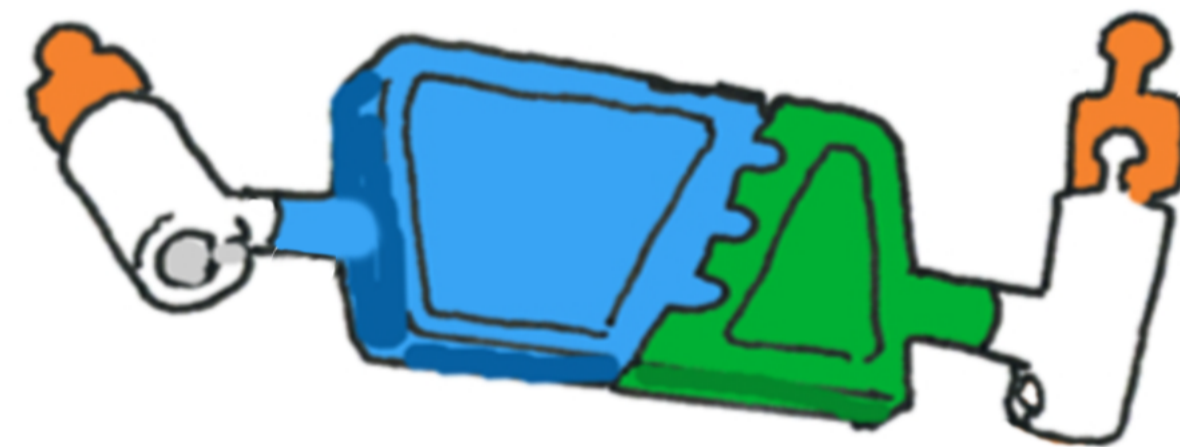DNA is **two strands** of nucleotides, wrapped around each other in a tight embrace. They embrace because all the bases of one strand fit perfectly with the bases of the other strand, like puzzle-pieces: each kind of base is **complementary** to (fits with, and sticks to) one other kind of base.

THE complementary base pairs of DNA are:

Adenine and **Thymine**
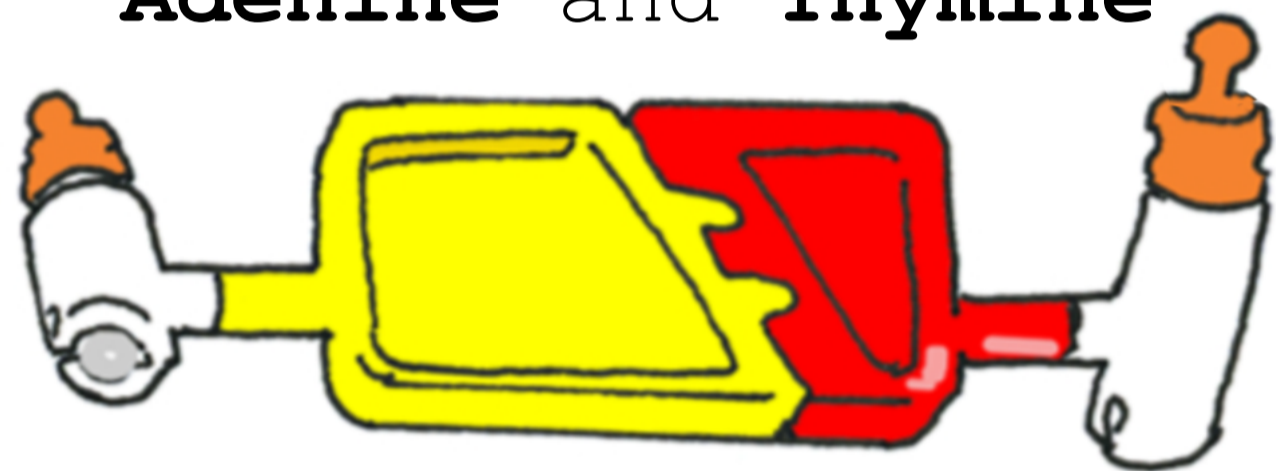
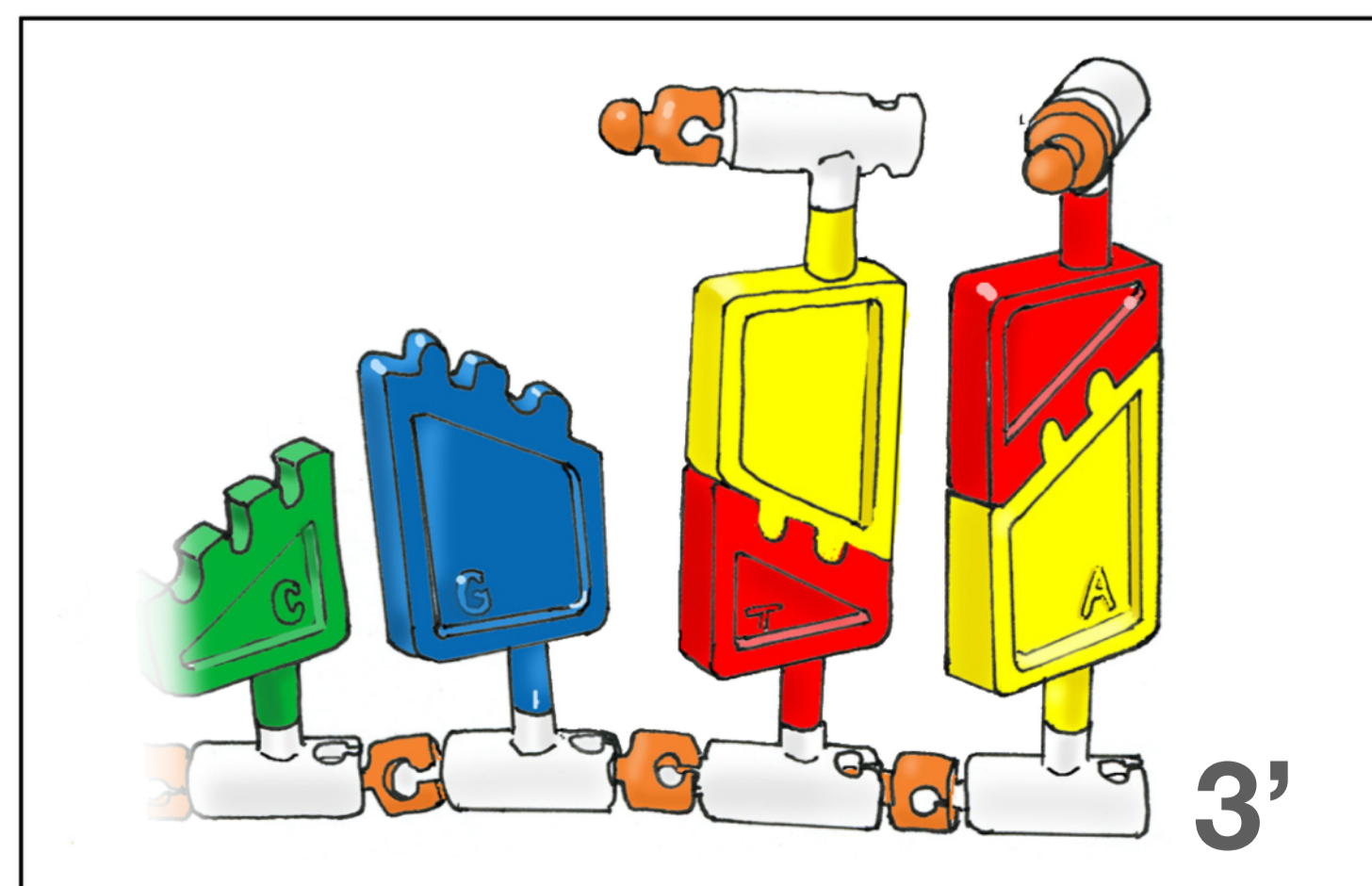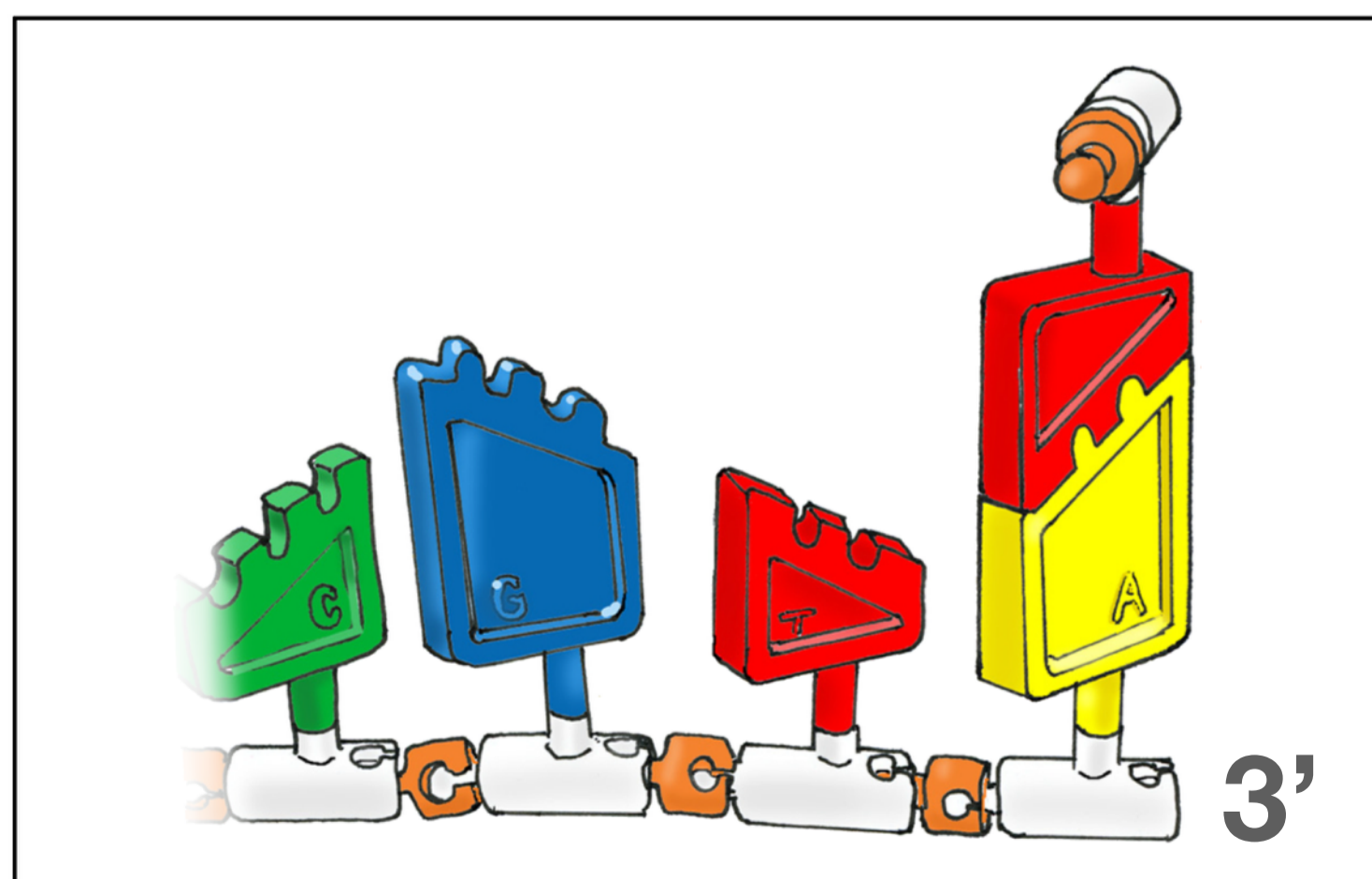**Guanine** and **Cytosine**

One strand is built first.
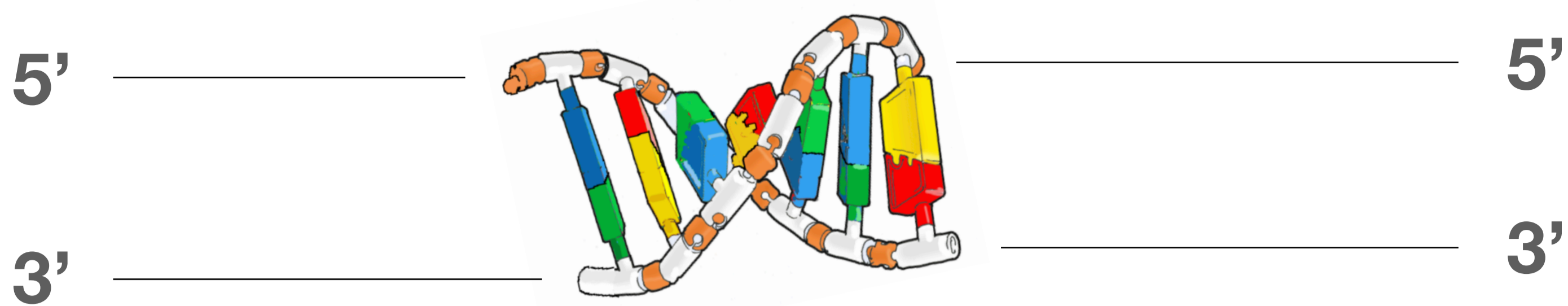**Then the second strand is built to match the first one.**

1. To begin: gather nucleotides for the first strand into a pile. Gather them one by one. For every nucleotide you throw into the pile, put a complementary nucleotide aside into a second pile.

2. Build the first strand. Link nucleotides in the order specified by your teacher. If not specified, just grab from the pile and link them up.

3. Starting at the 3' end of the built strand, add complementary nucleotides as shown below. These are the beginning of your second strand.
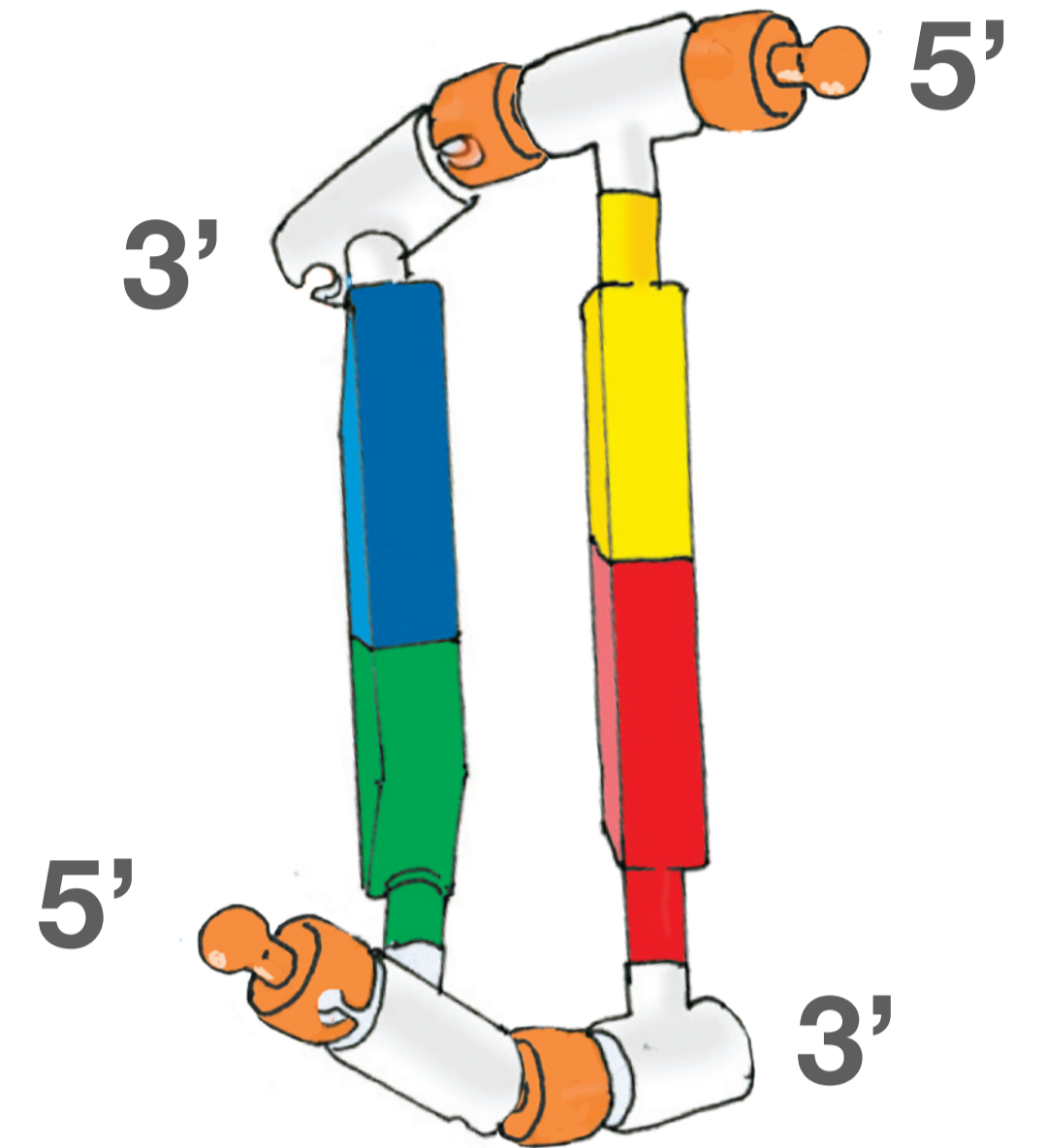
FORMING THE DOUBLE HELIX.
## II. Antiparallel strands

The nucleotides in the two DNA strands have their asymmetry pointed in opposite directions. We call this relative configuration **antiparallel**.

The example under construction will go like this:

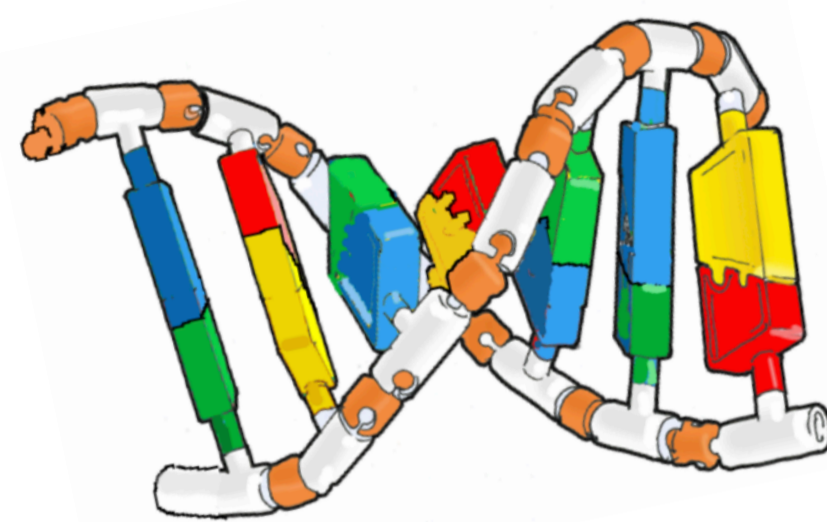## 3'-GCAT-5' (new strand)
5'-CGTA-3' (old strand)

Start building the new strand's **backbone** (yes, that is what it's called) by plugging the 5' phosphate end of the second nucleotide into the 3' sugar end of the first nucleotide.
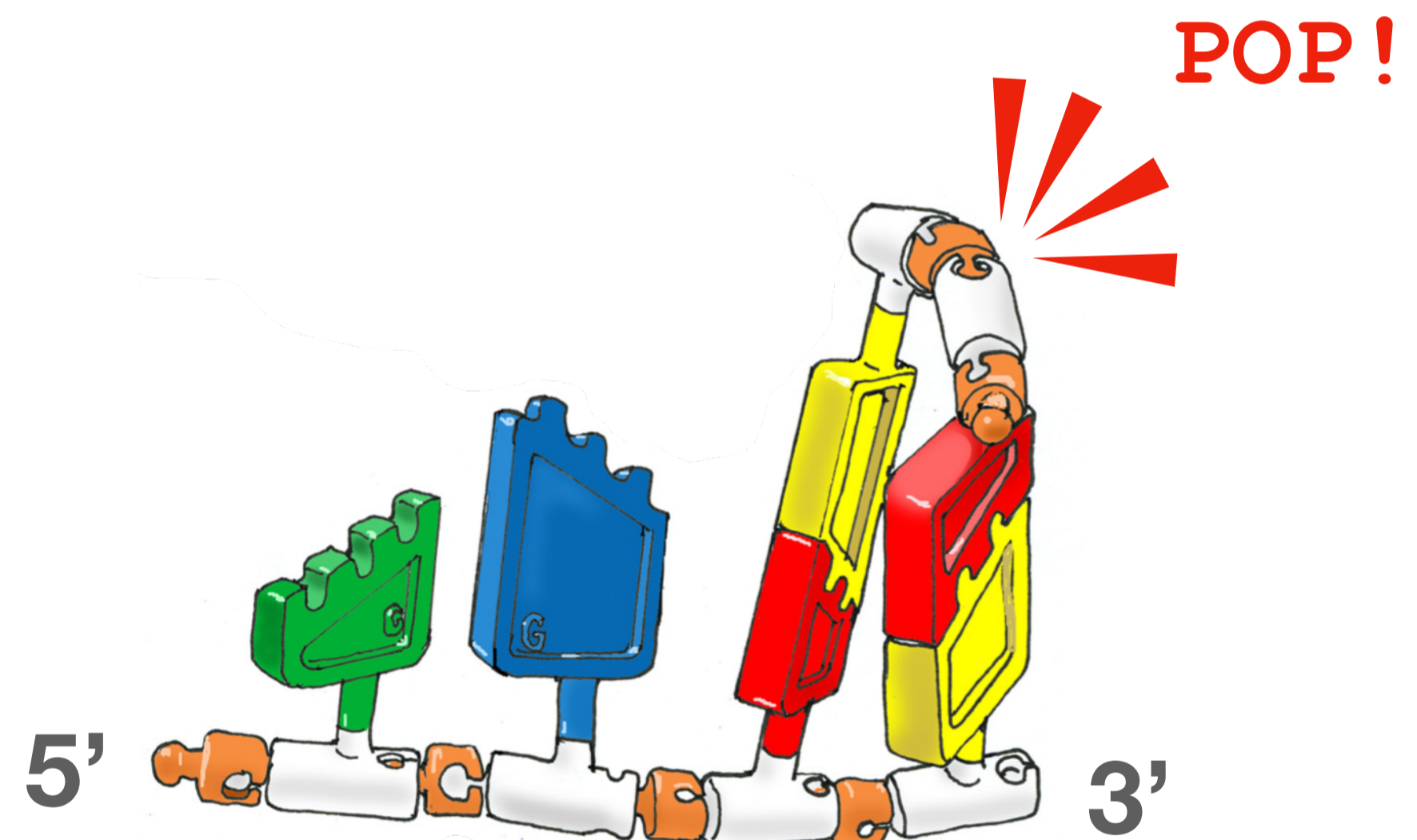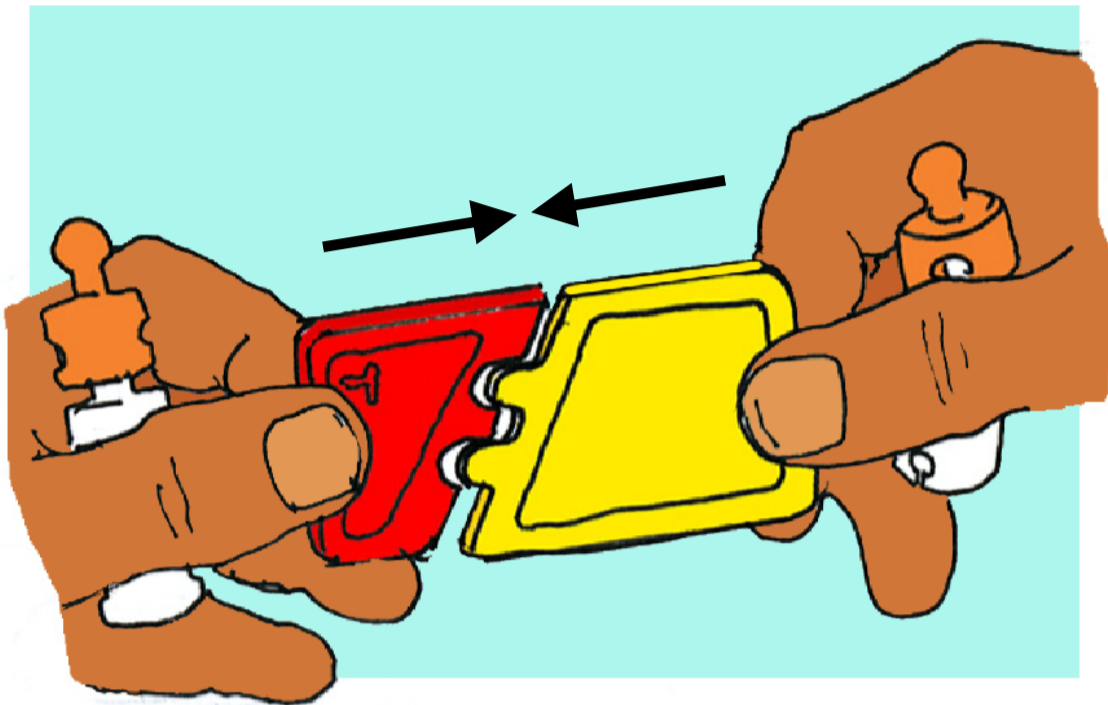
As you add more complementary nucleotides, link them up in the same way to build the phosphate-sugar backbone of the new strand.
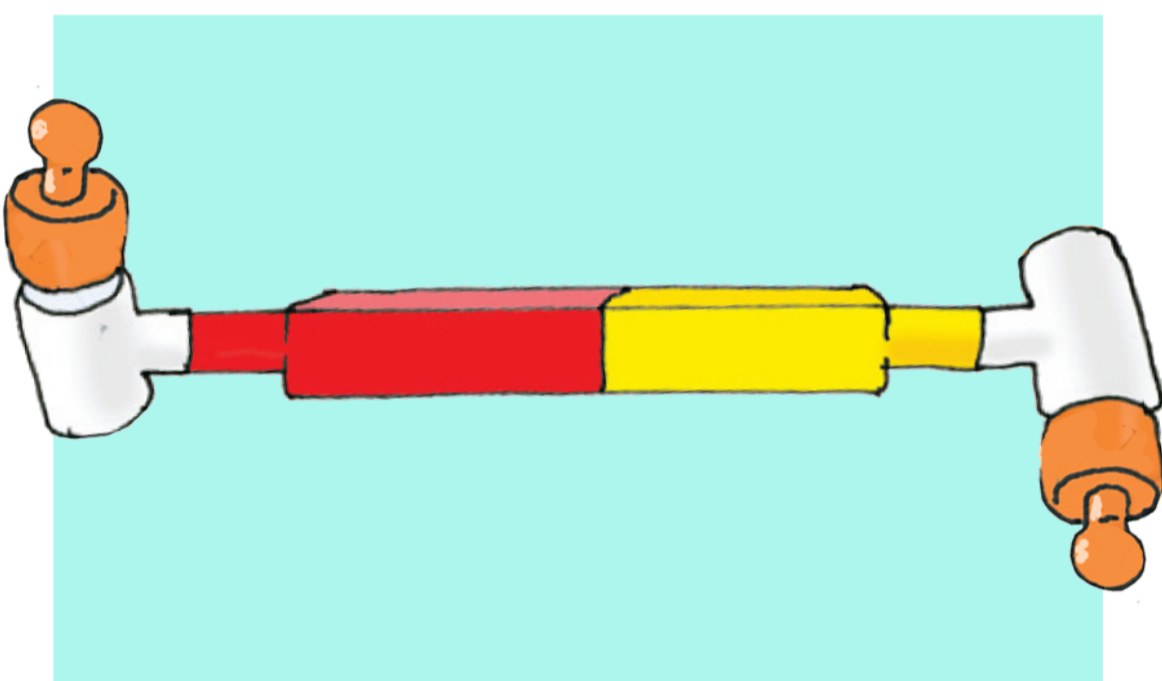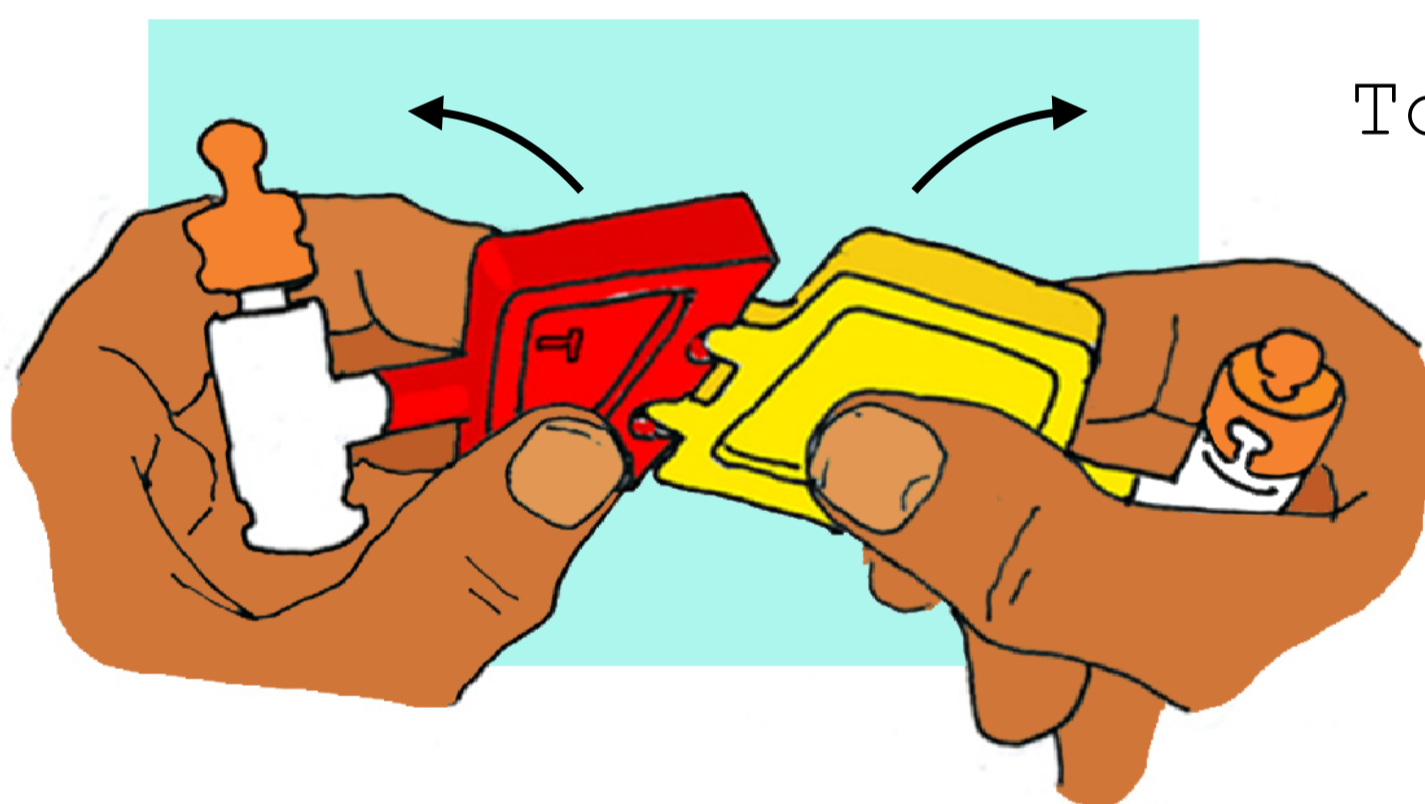
**POP!**
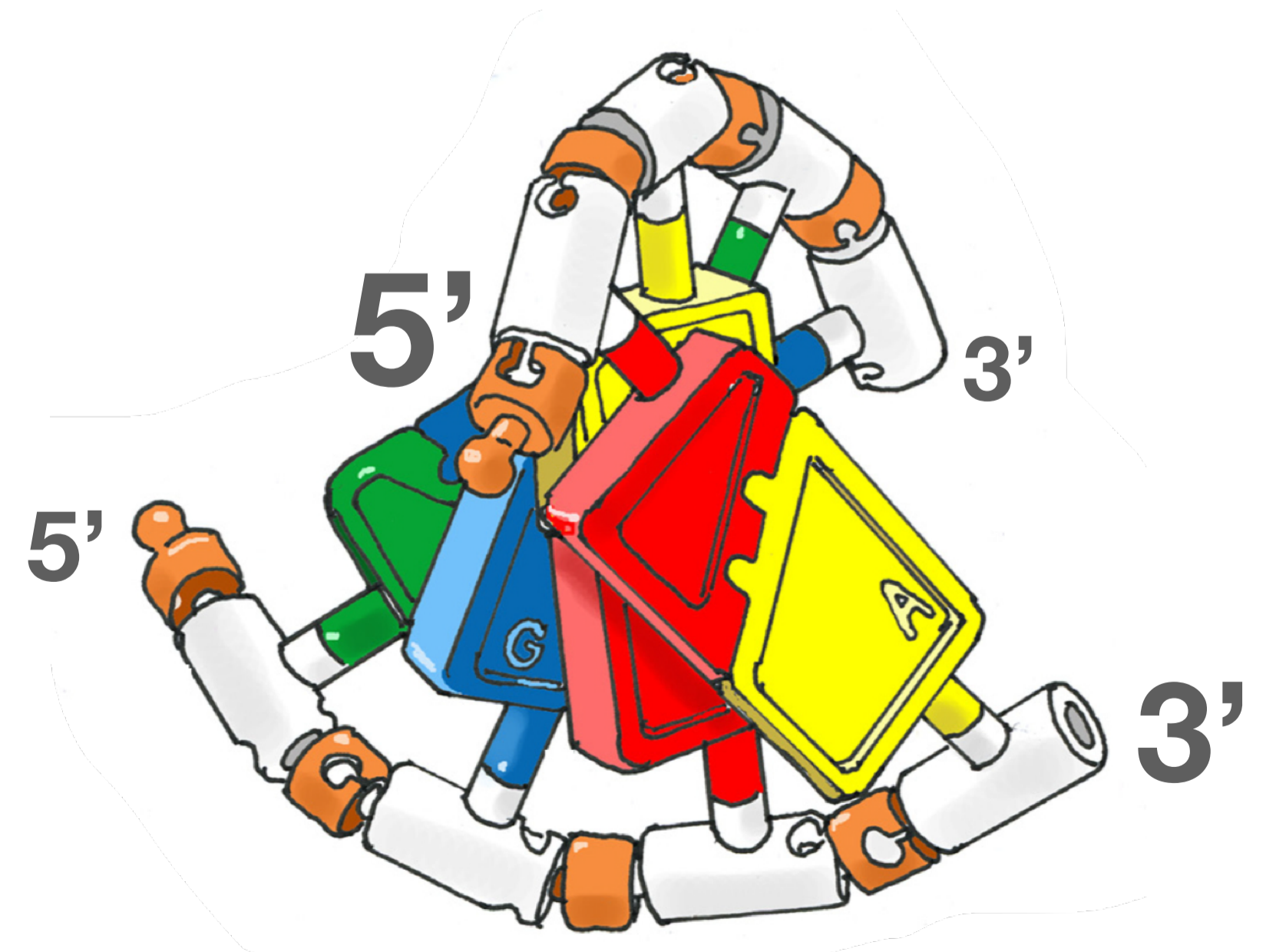
PlayDNA!

More Handling Tips

When joining a pair of complementary nucleotides, push them straight together, gripping the bases firmly while pushing the sugars with the palms of the hands.

BEFORE pushing them together, make sure paired bases are lined up flush with each other!

To separate base-paired nucleotides, apply torque - like breaking a crispy cracker in half.
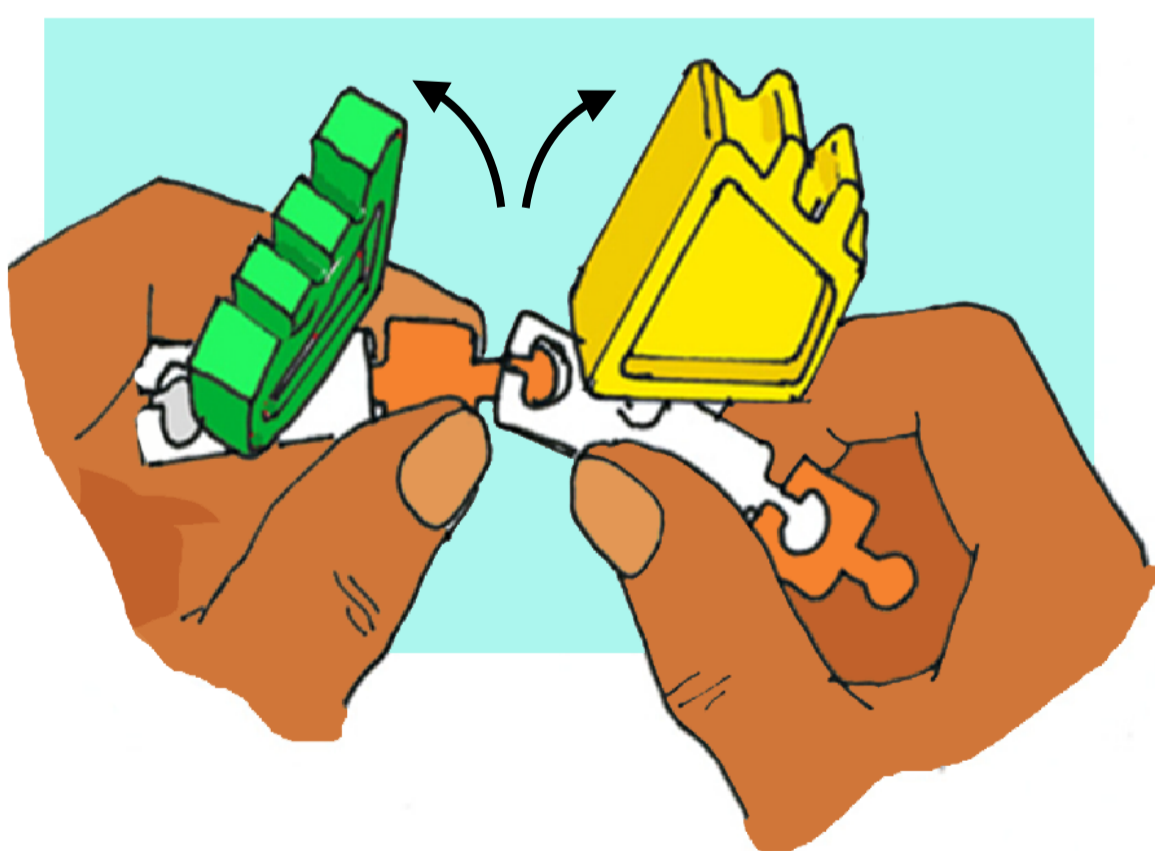
Torque is also the easiest way to undo the pop-bead connections of the phosphate-sugar backbone.

For displaying PlayDNA structures, use fishing line to dangle them so they can twirl!