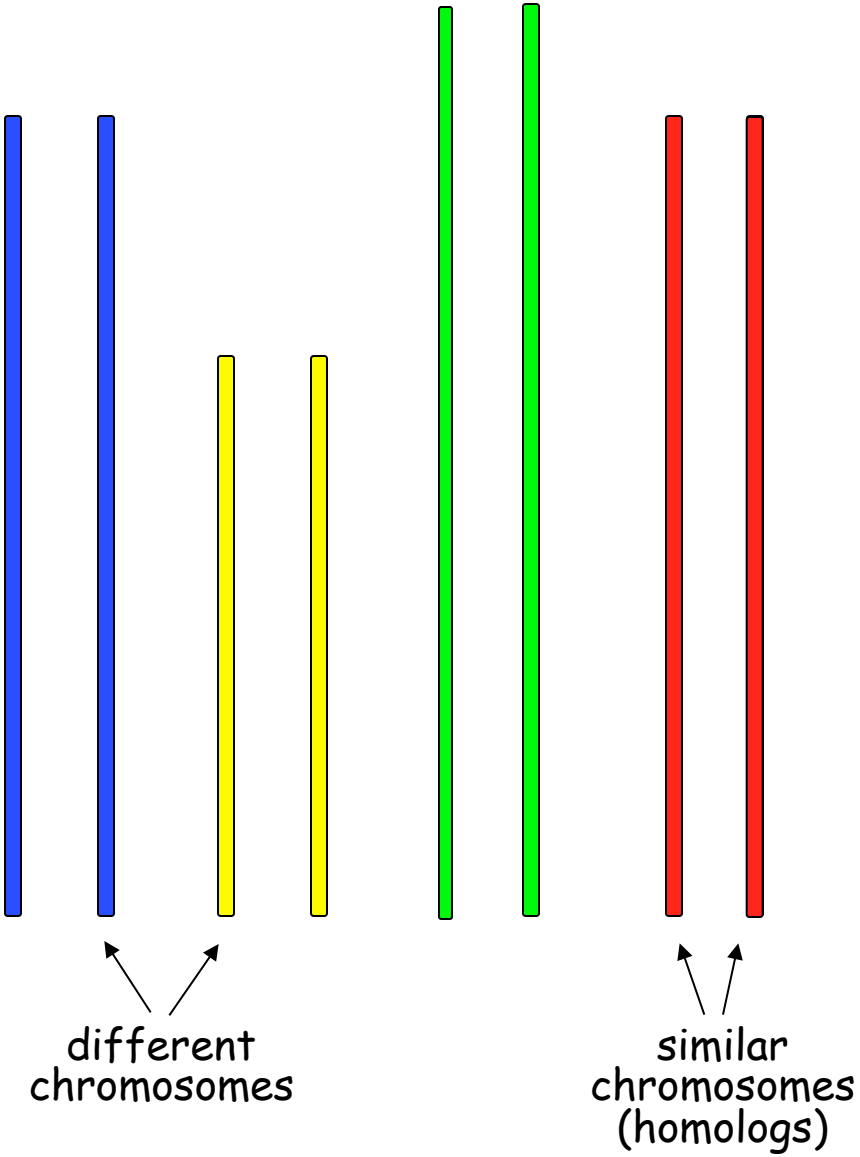
Chromosomes

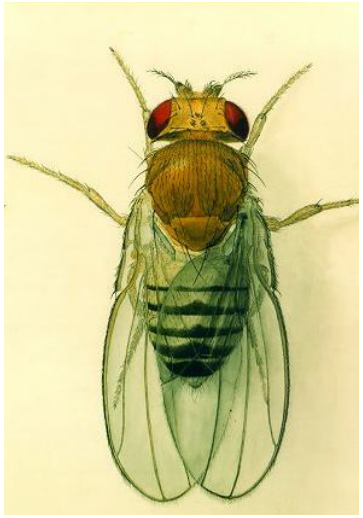
The big questions:

- Which chromosomes in a nucleus are similar?
- Which are identical?
- Which are completely different?

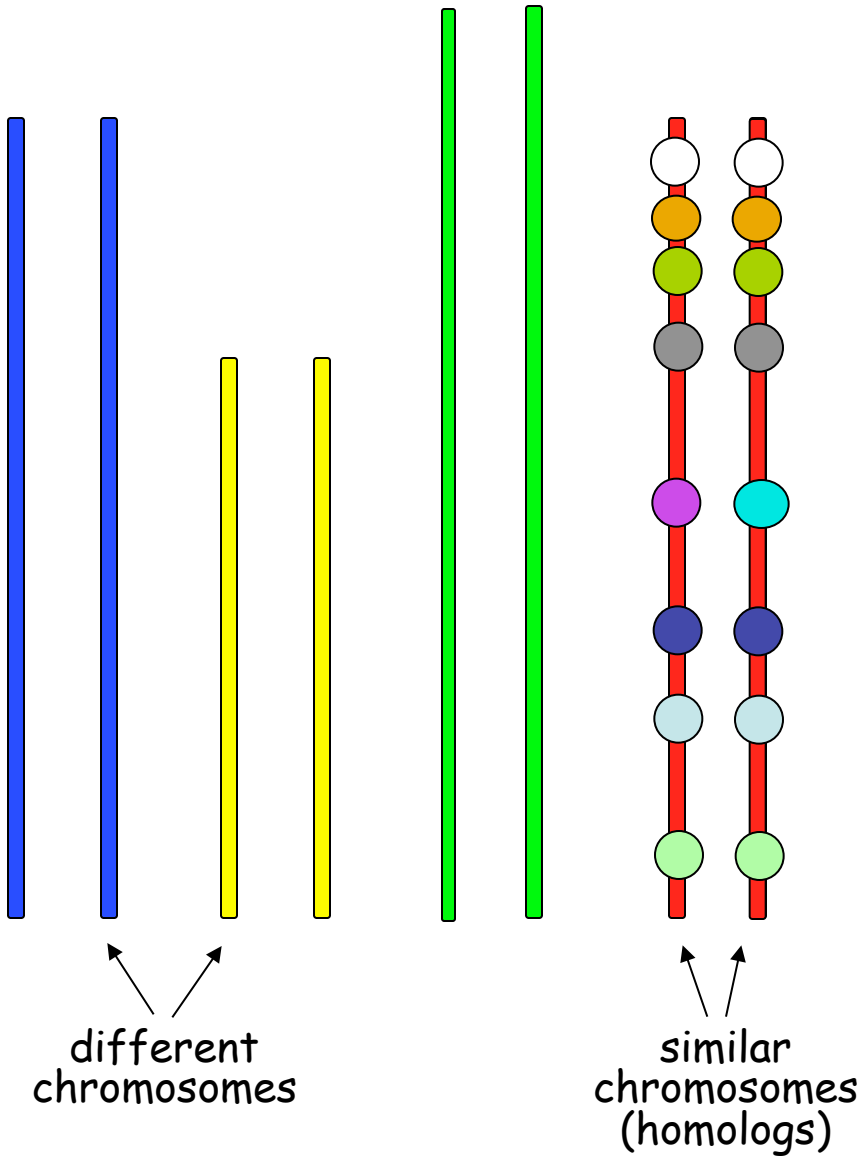
- How do chromosomes align during mitosis?
- How do chromosomes align during meiosis?

Using pipe cleaners to represent the chromosomes in a fruit fly:



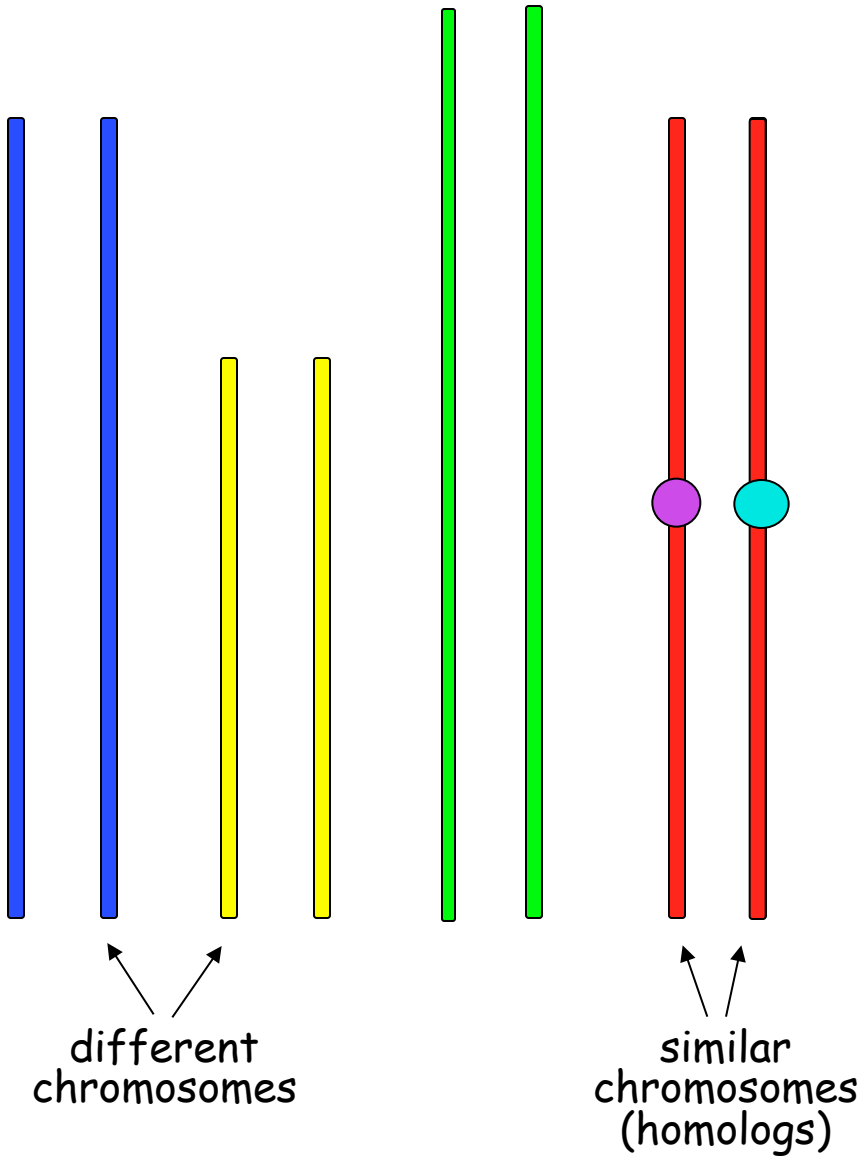


Add beads to represent genes (colors can show alleles):

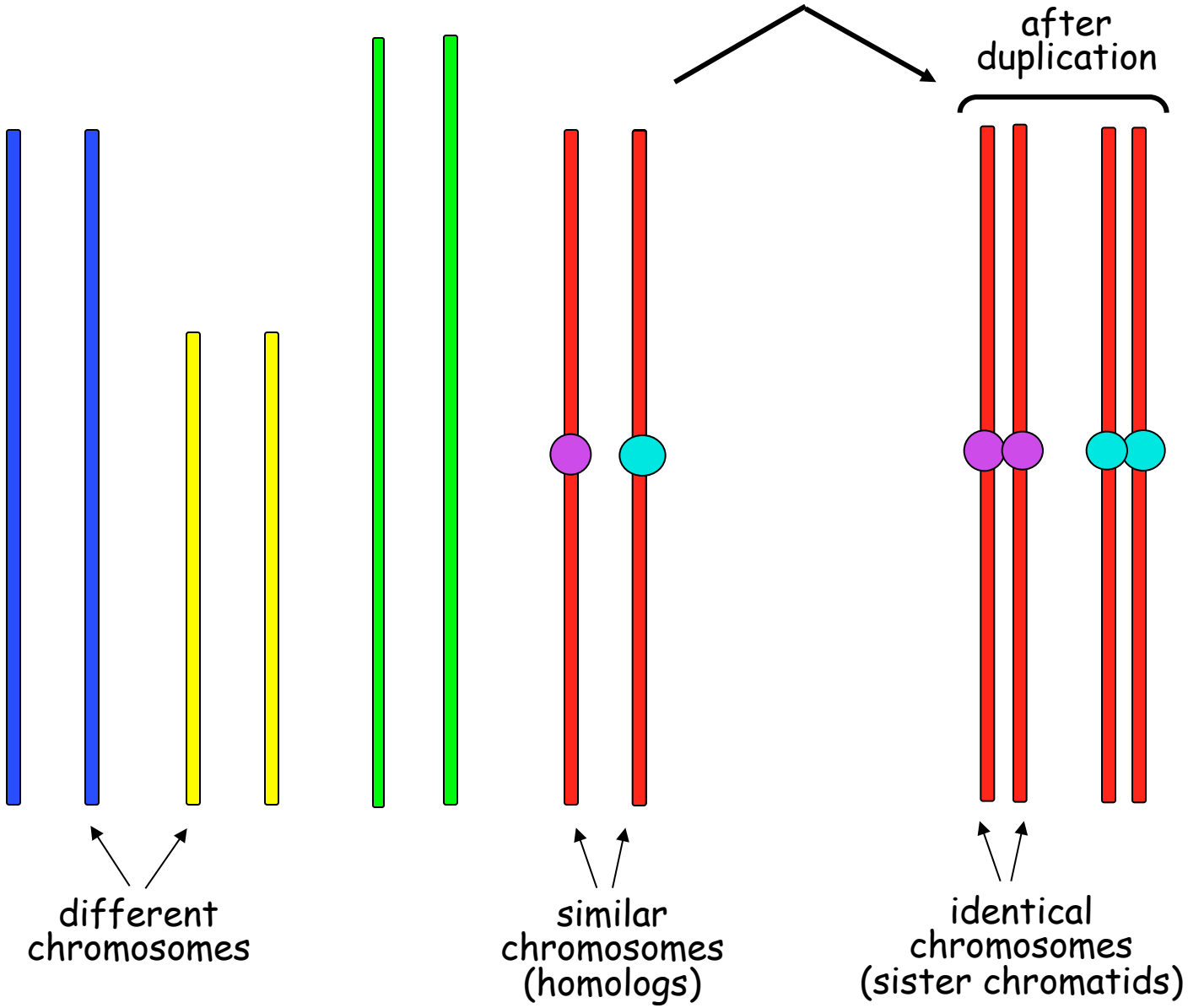


Leave just the different color/allele beads

… to mark the homologs:



Duplicate the chromosomes in preparation for division:

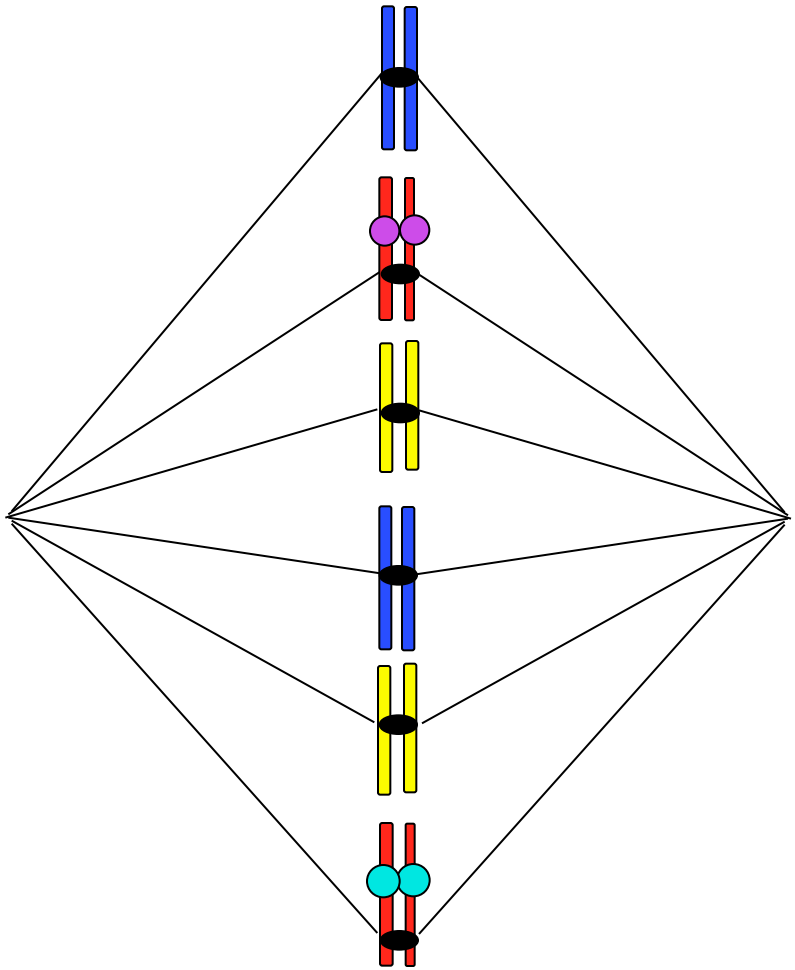


Student activities:

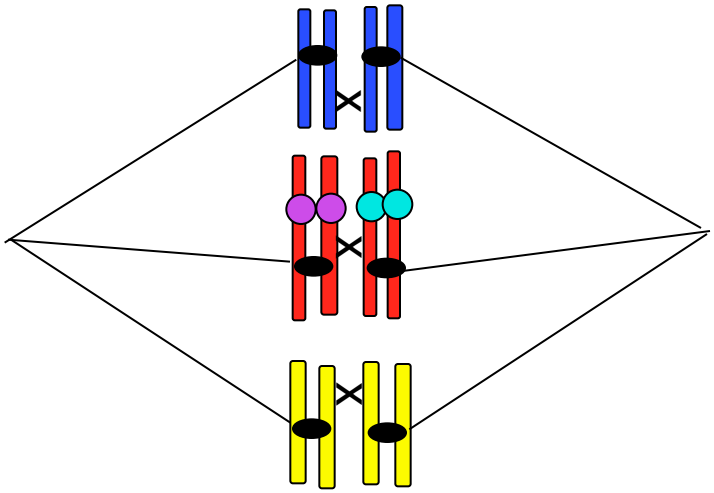
- Model mitosis and meiosis with pipe cleaners & beads
- Devise 2D drawings
- Practice (going back and forth between pipe cleaners and drawings as needed)
- Apply pipe cleaners and beads to new situations

Create chromosomes for a 2n=6 organism

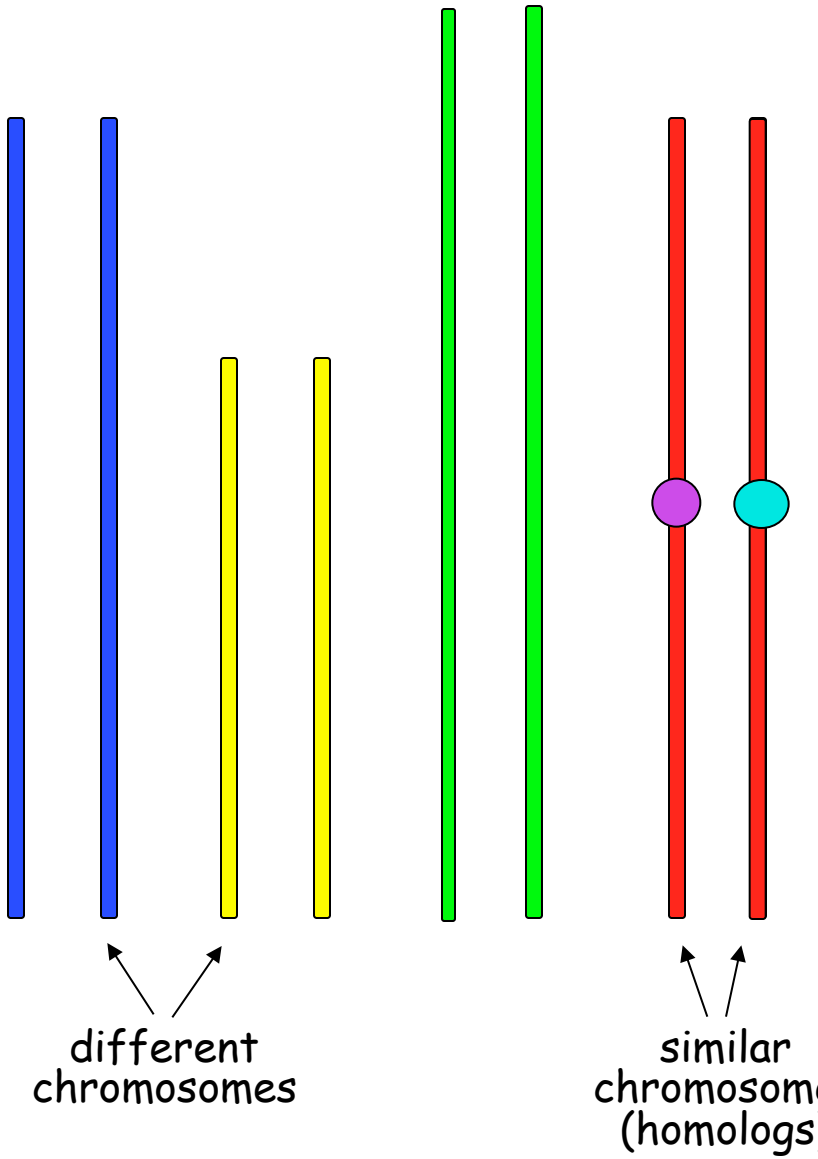
model mitosis



model meiosis



Other uses of pipe cleaners and beads:



Ploidy

-model trisomy vs triploidy

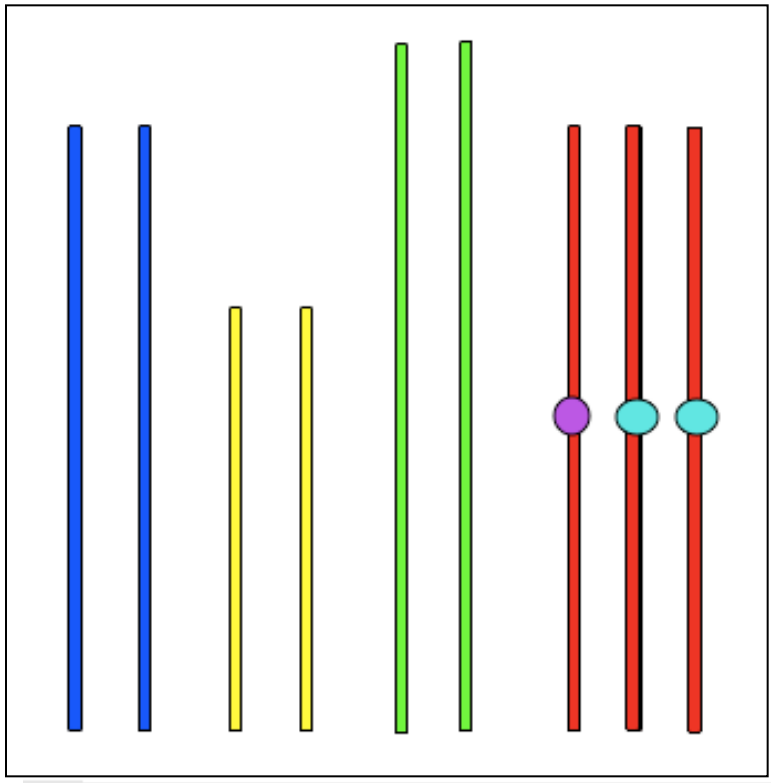
Complementation

-model complementation
vs failure to complement

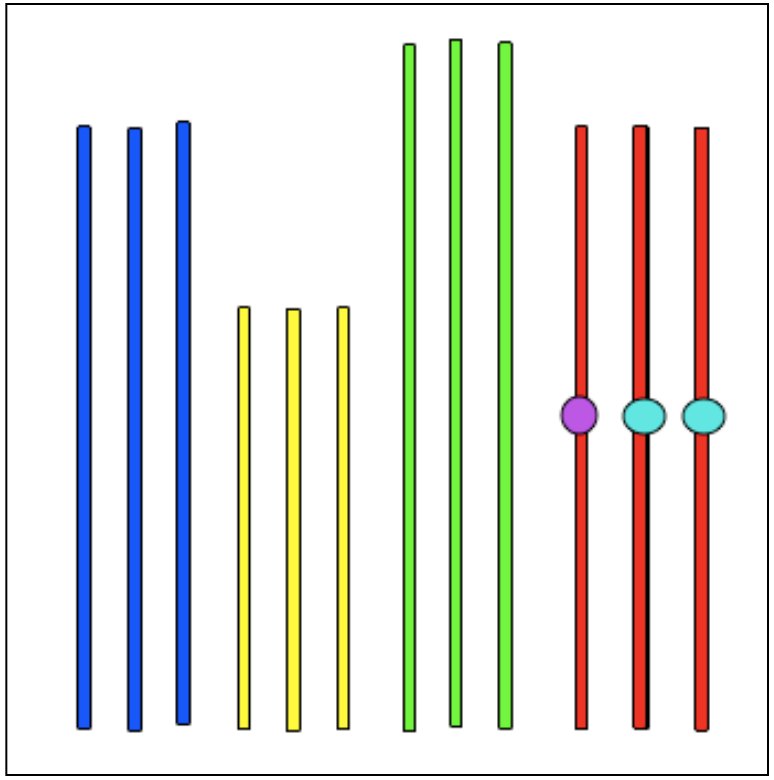
Other uses of pipe cleaners and beads:

Ploidy

model trisomy



model triploidy

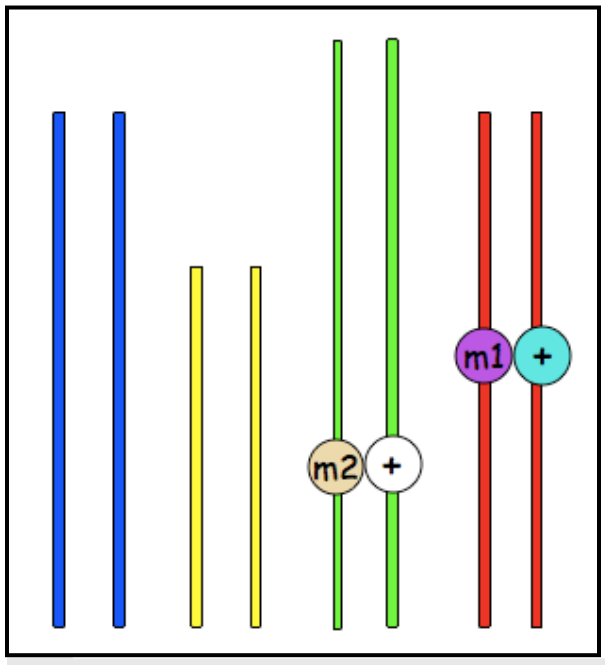


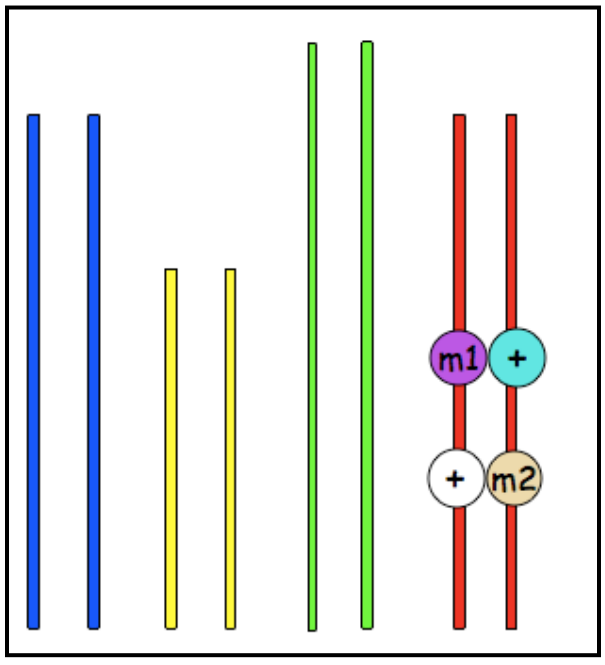
Other uses of pipe cleaners and beads:

Complementation

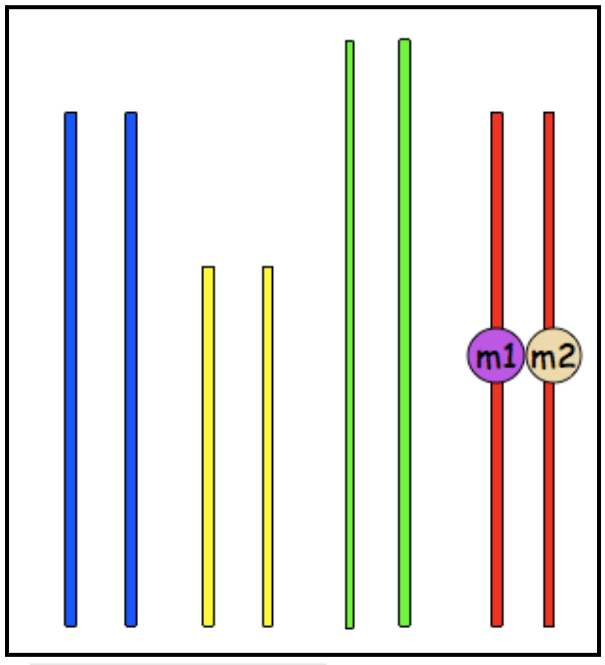
m1/m1 homozygotes show a particular phenotype.
m2/m2 homozygotes show the same phenotype.
Are m1 and m2 mutations in the same gene or in different genes?

model
complementation





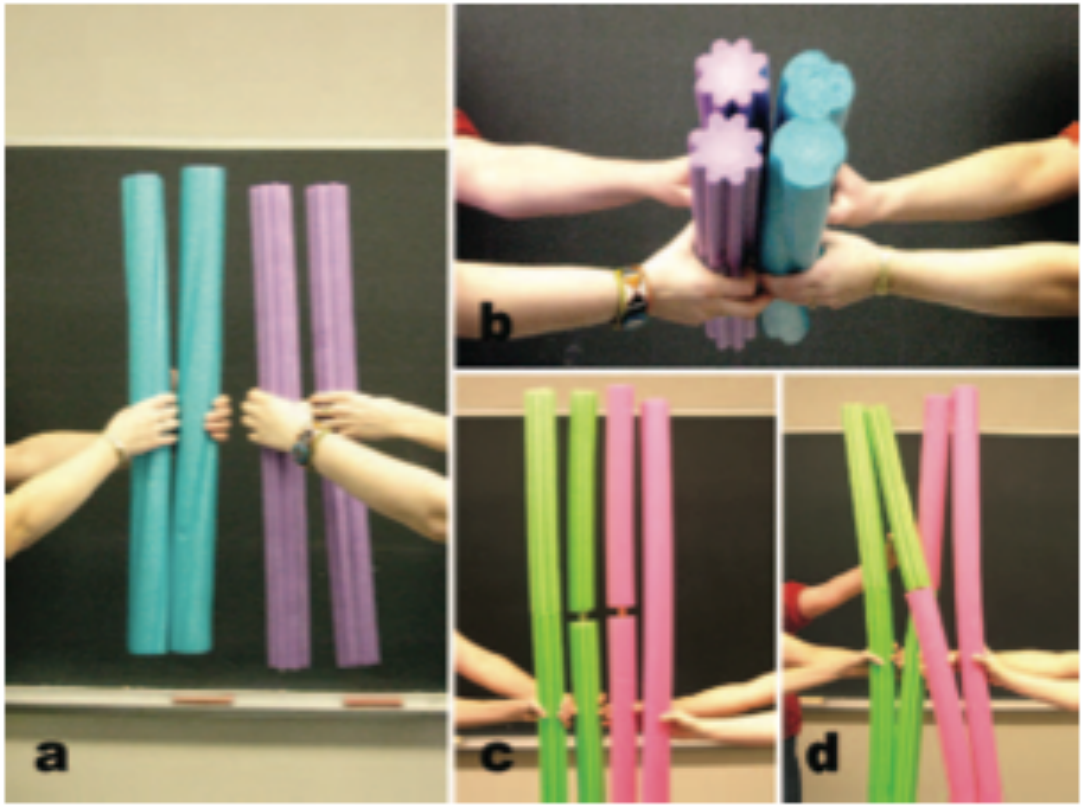
model
failure to complement



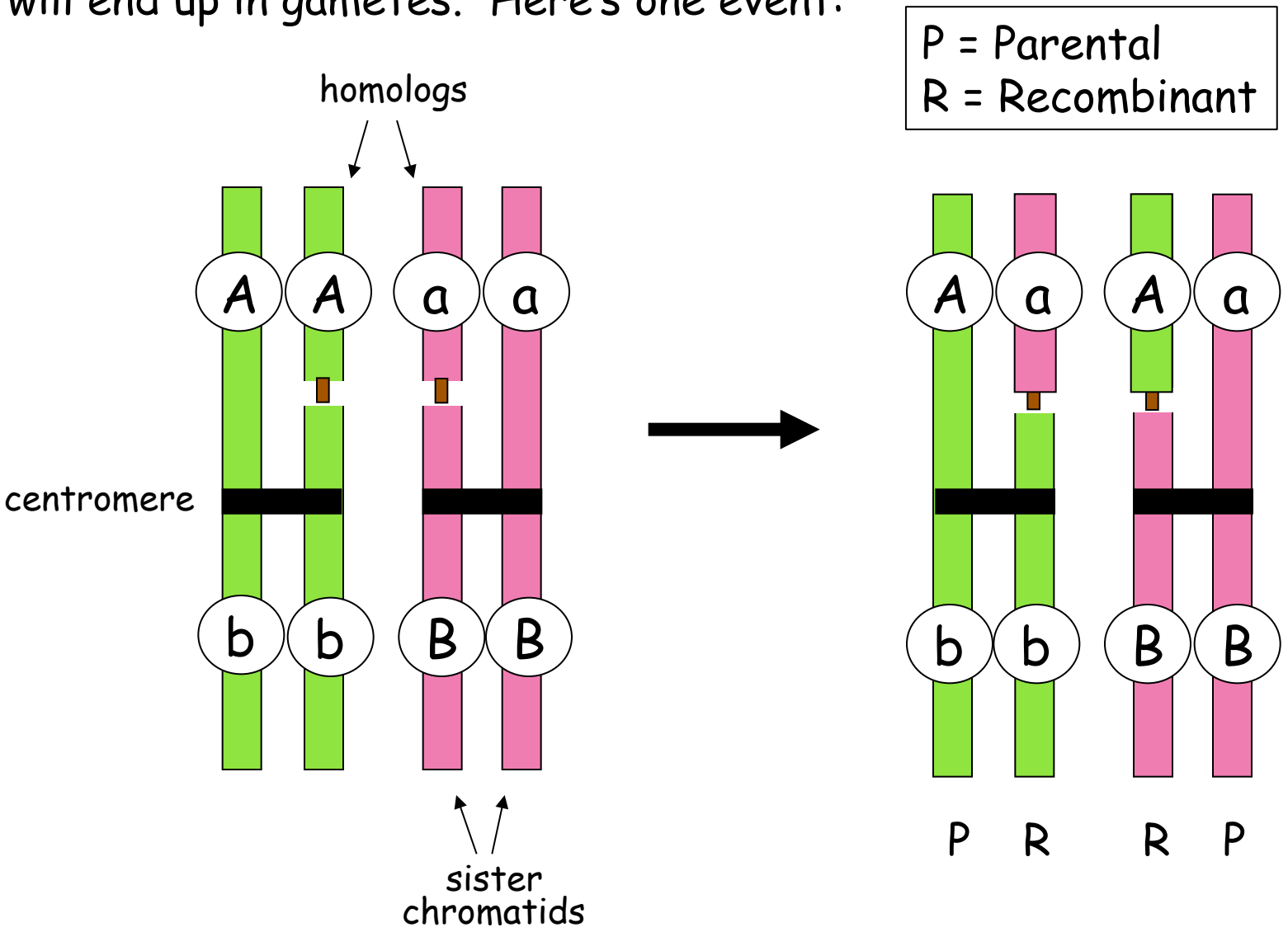
Crossing Over
and
Recombinant Chromosomes

Using pool noodles to discuss crossing over and % recombinants

Locke & McDermid (2005) *Genetics* 170: 5-6
describe using pool noodles to teach mitotis and meiosis, as shown below



Pool noodles are great for allowing the students to create many different cross-over events and see the consequences, e.g., recombinant and parental (non-recombinant) chromosomes that will end up in gametes. Here's one event:



Activation of Gene Expression

How do genes get "turned on" in response to signals? This skit brings the process to life, and helps students think about dynamic processes and the importance of drawing cartoon renditions.

Example: How steroids (e.g. testosterone) turn on genes for maleness, a lesson designed by Roger Innes

A description of the process in words:

1) Steroids bind to proteins called "receptors".

2) Steroid receptors dimerize and bind DNA.

3) Steroid receptors that are bound to DNA recruit other proteins that function as "co-activators".

4) Coactivators recruit RNA polymerase, which binds to the promoter of a gene and initiates transcription.

I ask the students to create a living model depicting how testosterone "activates" expression of specific genes!

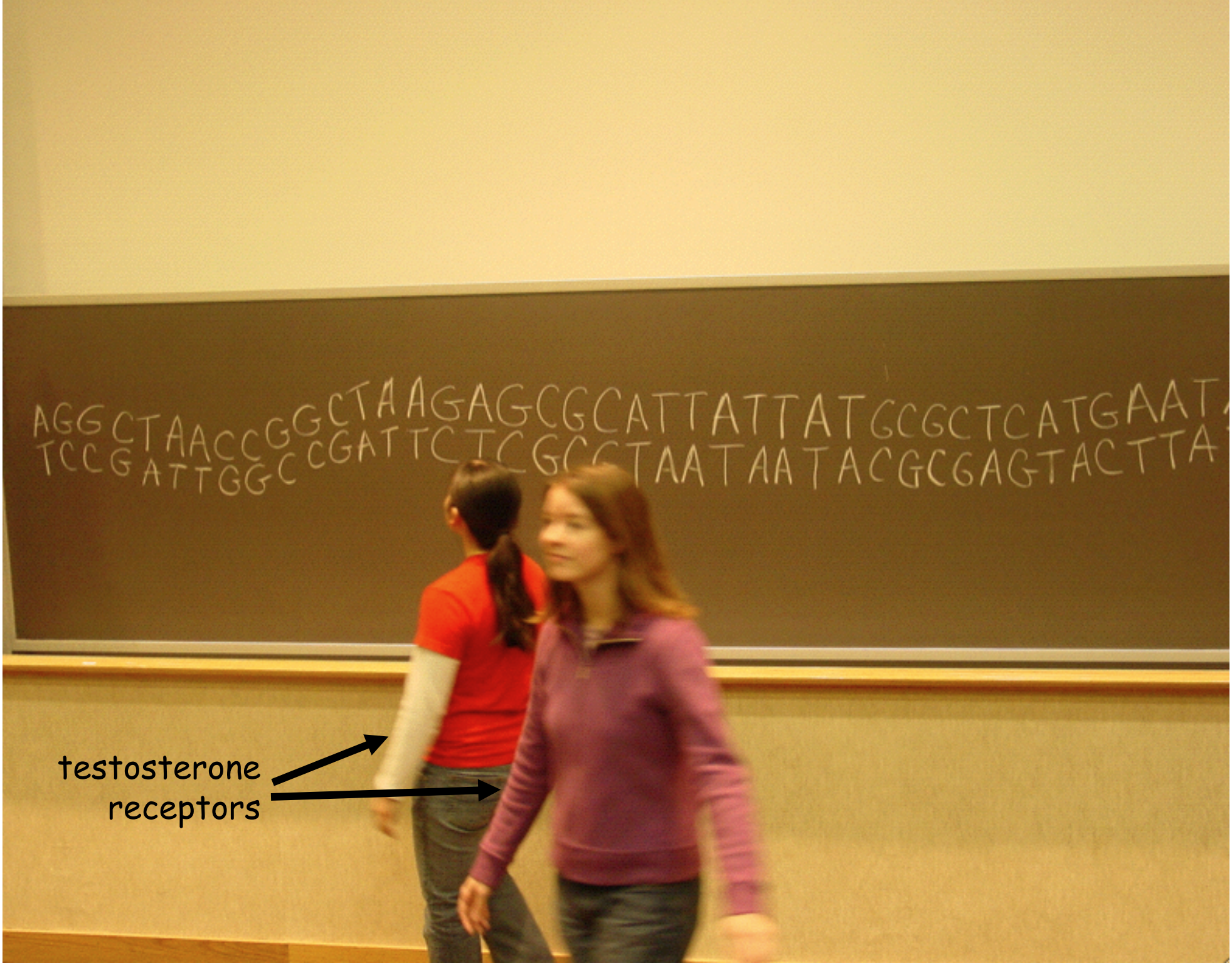
I need a group of 4 ----> 2 folks are testosterone receptor
1 is coactivator
1 is RNA polymerase

Using the proper sequence of events, act out the process of gene activation according to the following rules:

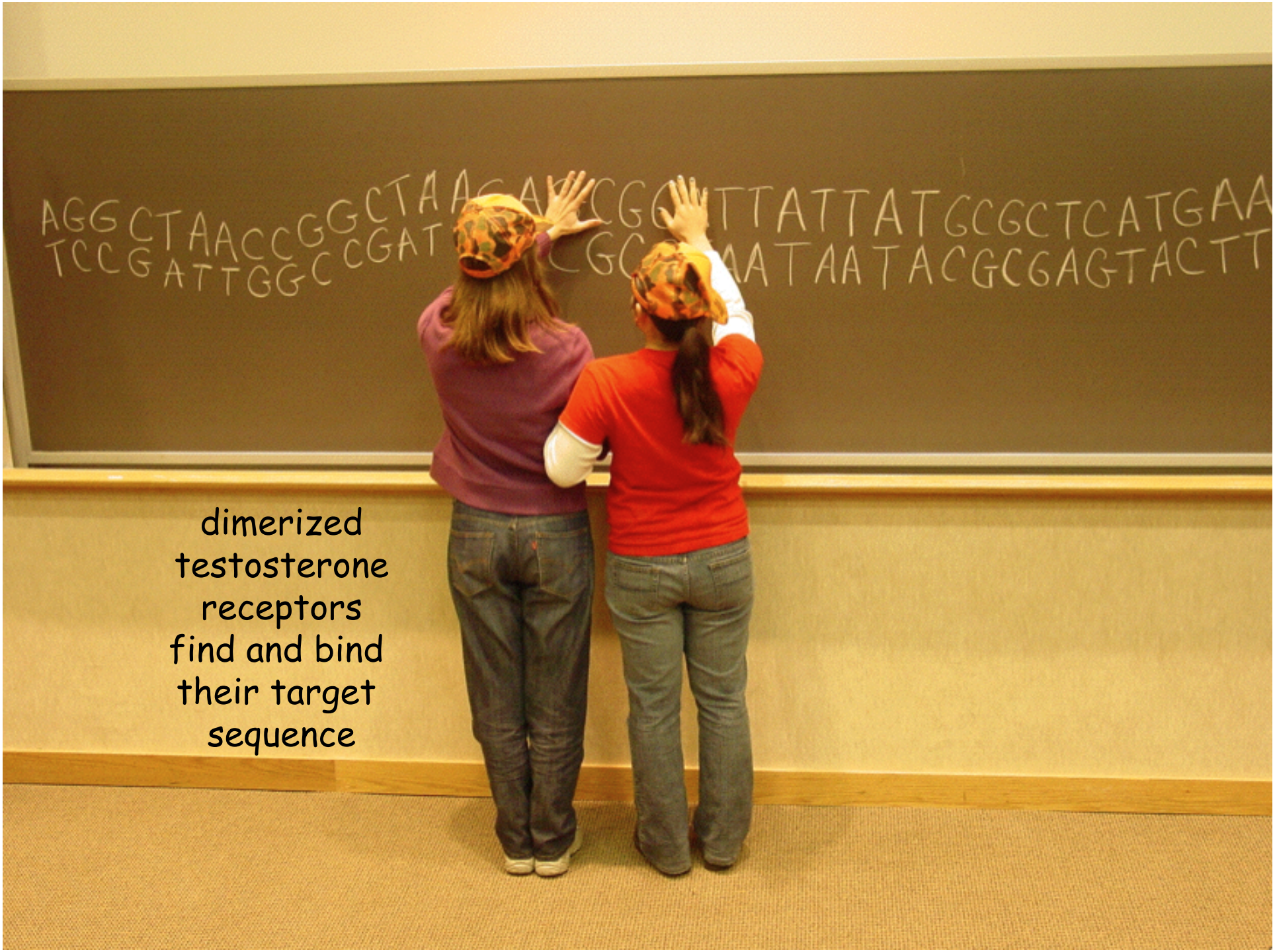
- Testosterone must be perceived.
- A gene with the following sequence must be found.

- Demonstrate the proper protein-protein and protein-DNA interactions.
- What is the end result?

The 96 students not acting out the living model direct the activities (the "fishbowl technique"; Silberman, 1996).


testosterone
receptors


dimerized
testosterone
receptors
with their
testosterone
"caps"


dimerized
testosterone
receptors
find and bind
their target
sequence


coactivator
is recruited


RNA polymerase
is recruited


transcription
of the
target gene

Assessment:

Students are asked to

1) Depict the steps of gene activation by testosterone in cartoon form.

2) List 1 or 2 questions that this modeling exercise and their cartoon raised in their mind.

Outcome:

1) Students realized the utility and importance of modeling … and how it can help them identify what they don't understand.

2) Many students posed intellectually sophisticated questions, similar to those that scientists are currently asking and testing.