University of California STEM FACULTY LEARNING COMMUNITY

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Faculty Learning Community Webinar

Today: **Experiments in Active Learning in Genetics Classes**

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Experiments in Active Learning In Genetics Classes

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Overview

- Lessons from Teaching Workshops

- Active learning in my Genetics class
  - diverse strategies to teach "bottlenecks"
  - movies in advance of class
  - group work in class

- Assessment
  - define learning objectives & align exams with those
  - pre-tests and post-tests
  - clickers in class

Lessons from Teaching Workshops

Indiana University Workshop in 2003

- identify a bottleneck in student learning
- identify misconceptions that impede student learning
- design a lesson to teach the bottleneck
- assess the effectiveness of the lesson

Summer Institute Workshop at CU-Boulder in 2015

- scientific teaching
- 3 themes: active learning, inclusivity, assessment
- design teaching modules "backwards"
- put more responsibility for learning on students
- encourage group work in class

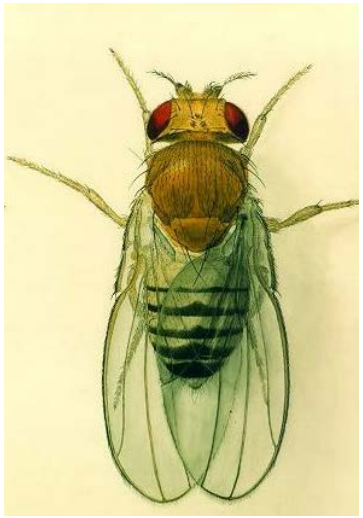
My Bottleneck in Genetics: Chromosomes

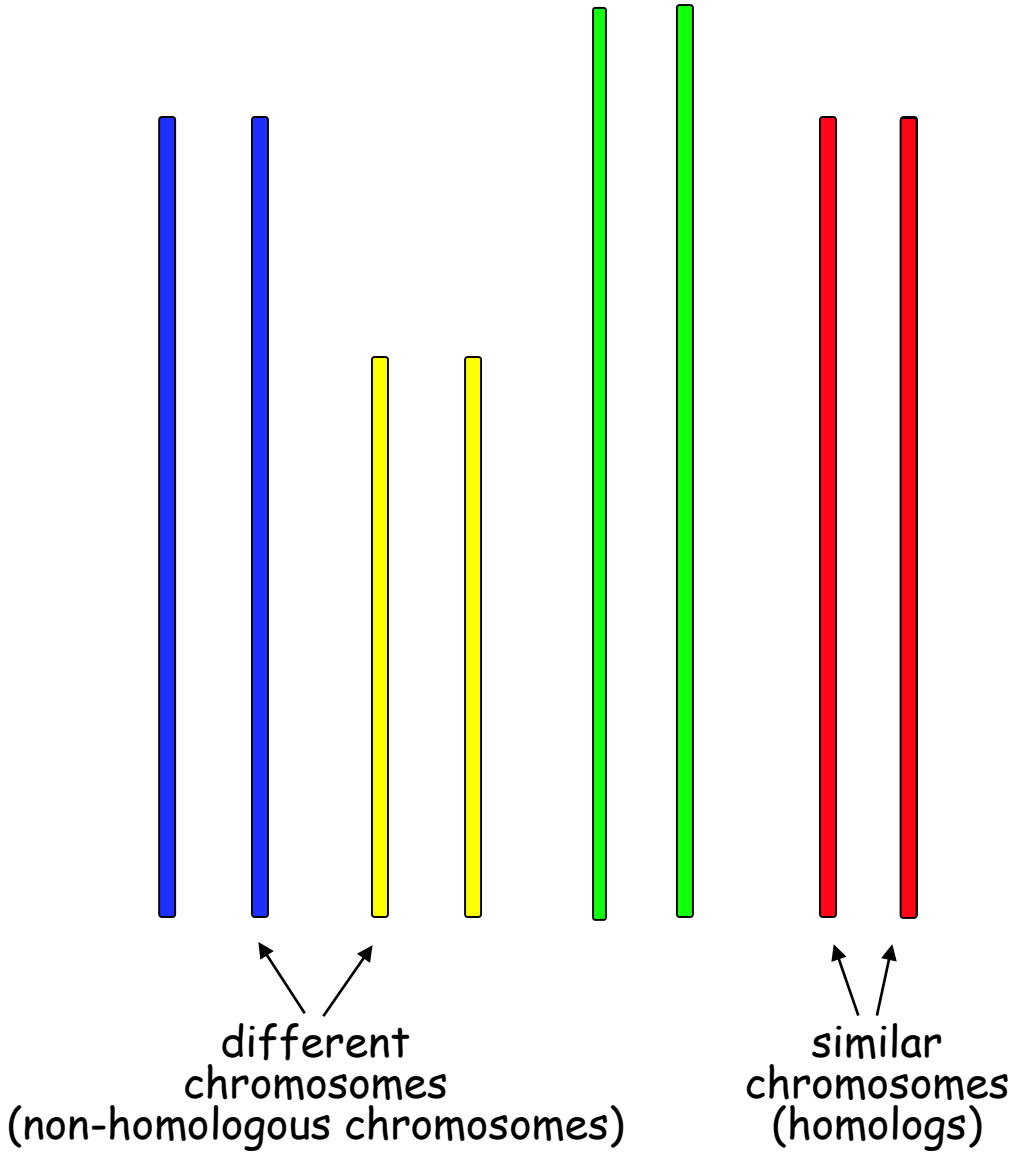
The big questions:

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

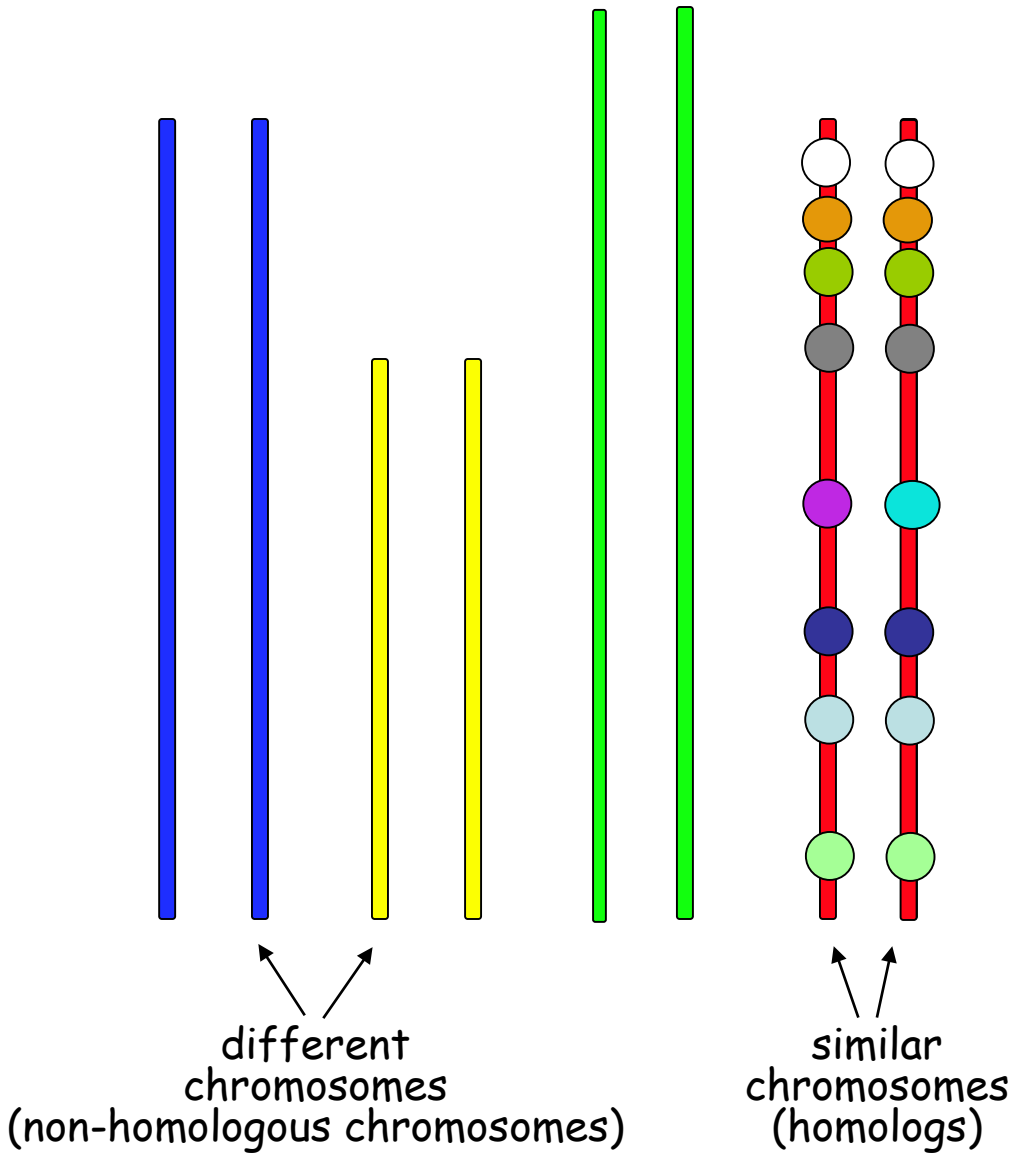
- How do chromosomes align during mitosis?
- How do chromosomes align during meiosis?

Use pipe cleaners to represent the chromosomes in a fruit fly

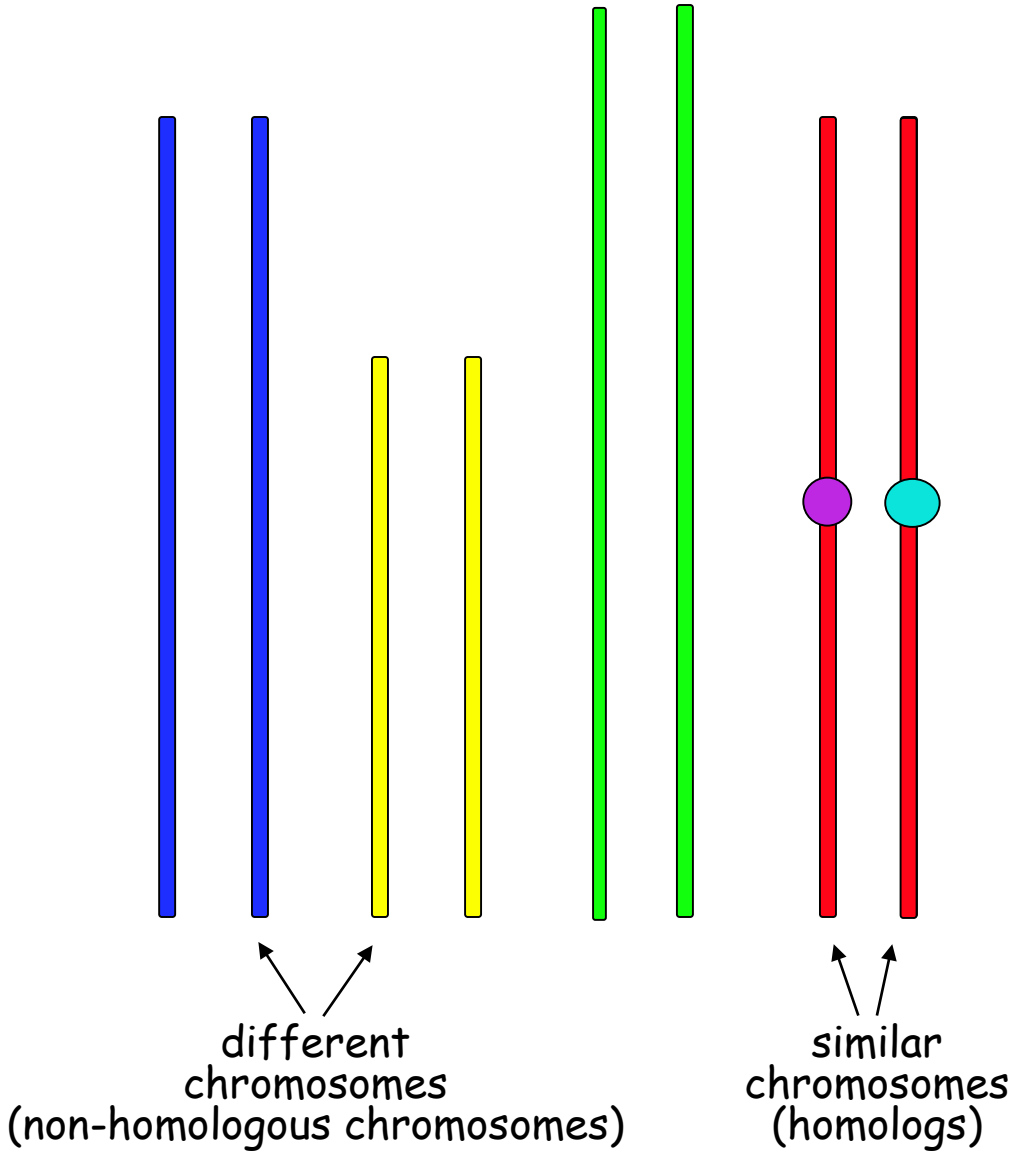




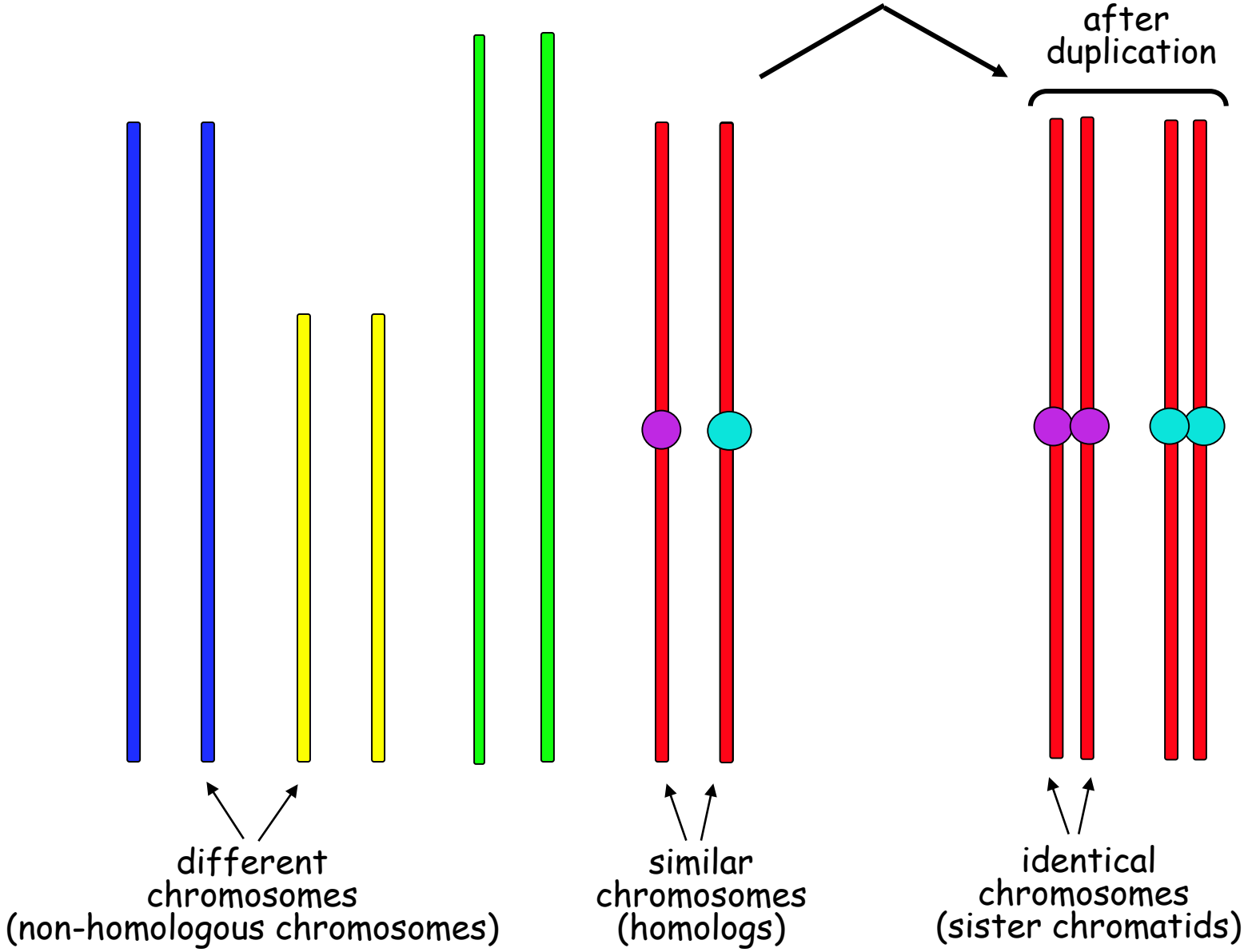
Add beads to represent genes (colors can show alleles)



Leave just the different color/allele beads
… to mark the homologs



Duplicate the chromosomes in preparation for division



Student activities (in class, discussion sections, workshops)

- Using pipe cleaners and beads:

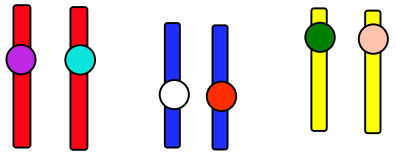
  Set up chromosomes in a 2n=6 cell in G1
  Show me the homologs, etc.
  Prepare chromosomes for mitosis or meiosis
  Model mitosis and meiosis
  Model trisomy vs triploidy

- Devise 2D drawings

- Practice going back and forth between pipe cleaners and drawings as needed

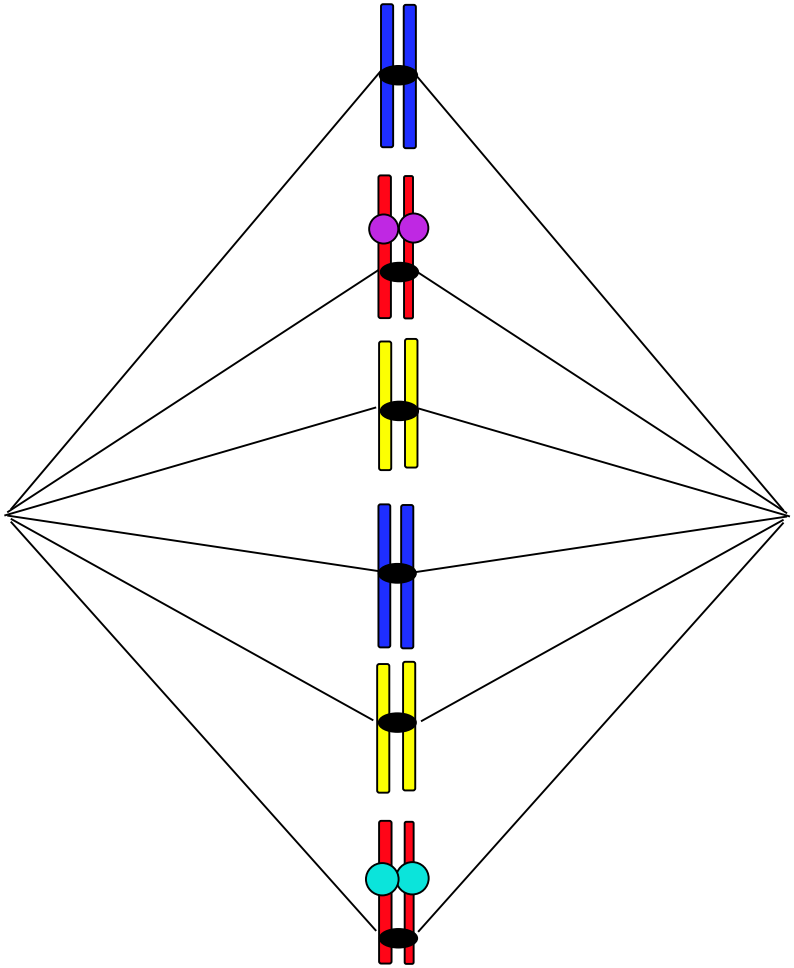
- Apply pipe cleaners and beads to new situations

Set up chromosomes in a 2n=6 cell in G1

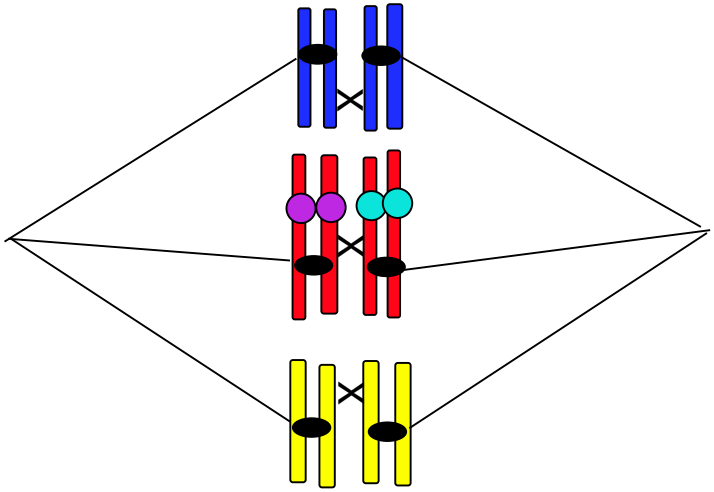


Prepare chromosomes for mitosis or meiosis

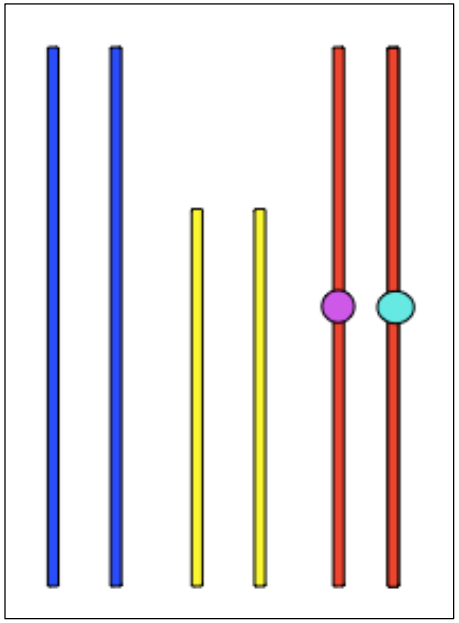
Model mitosis



Model meiosis

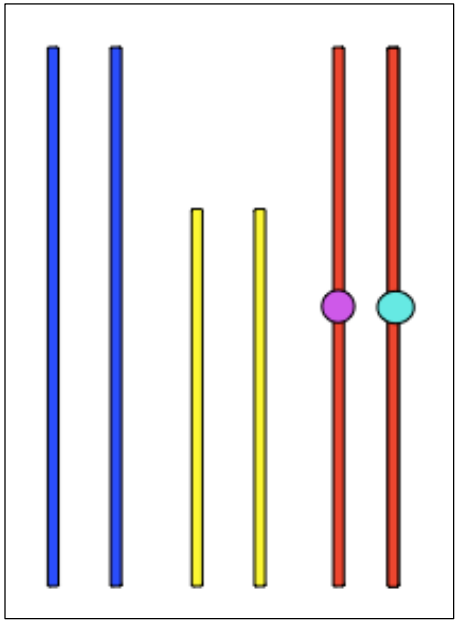


Model trisomy vs triploidy

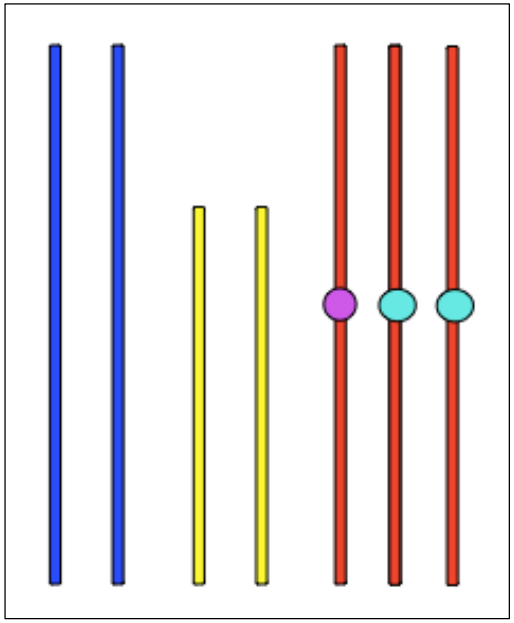


normal

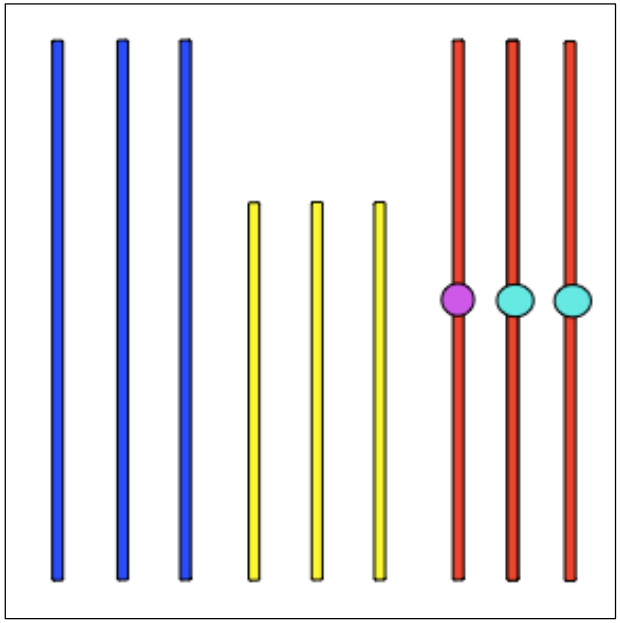
Model trisomy vs triploidy



normal



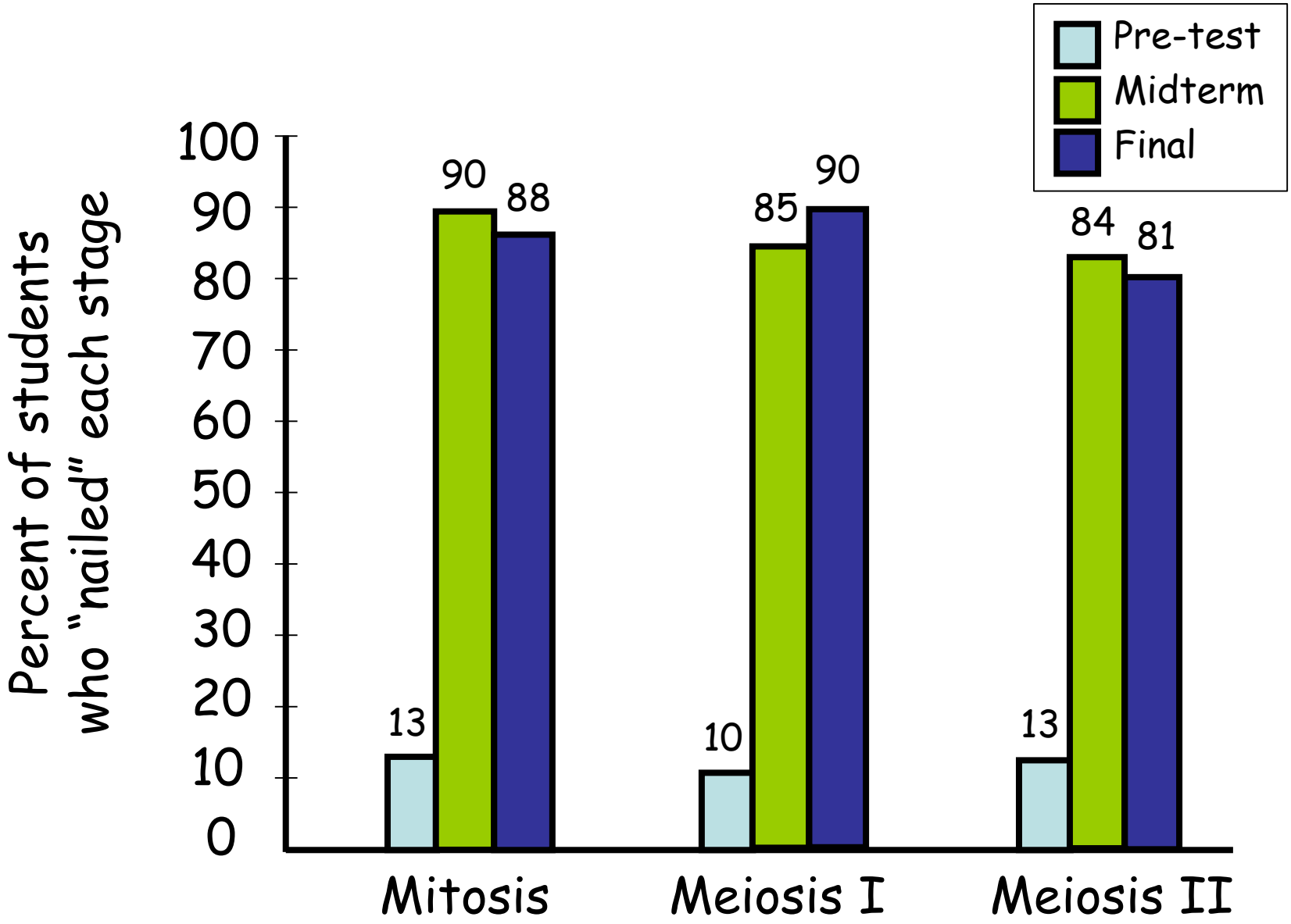
trisomy



triploidy

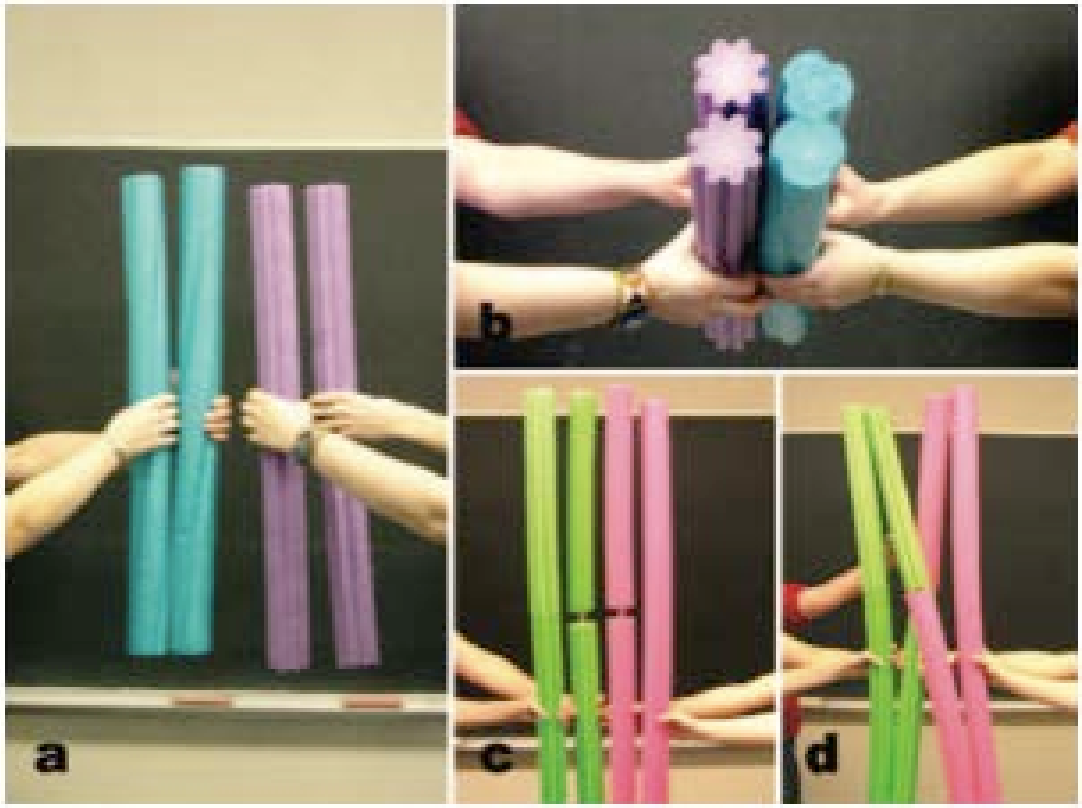
Assessment: Pre-tests and Post-tests

Students were asked to classify cartoons of chromosomes and alleles before the pipe cleaner exercise, on the midterm, and on the final

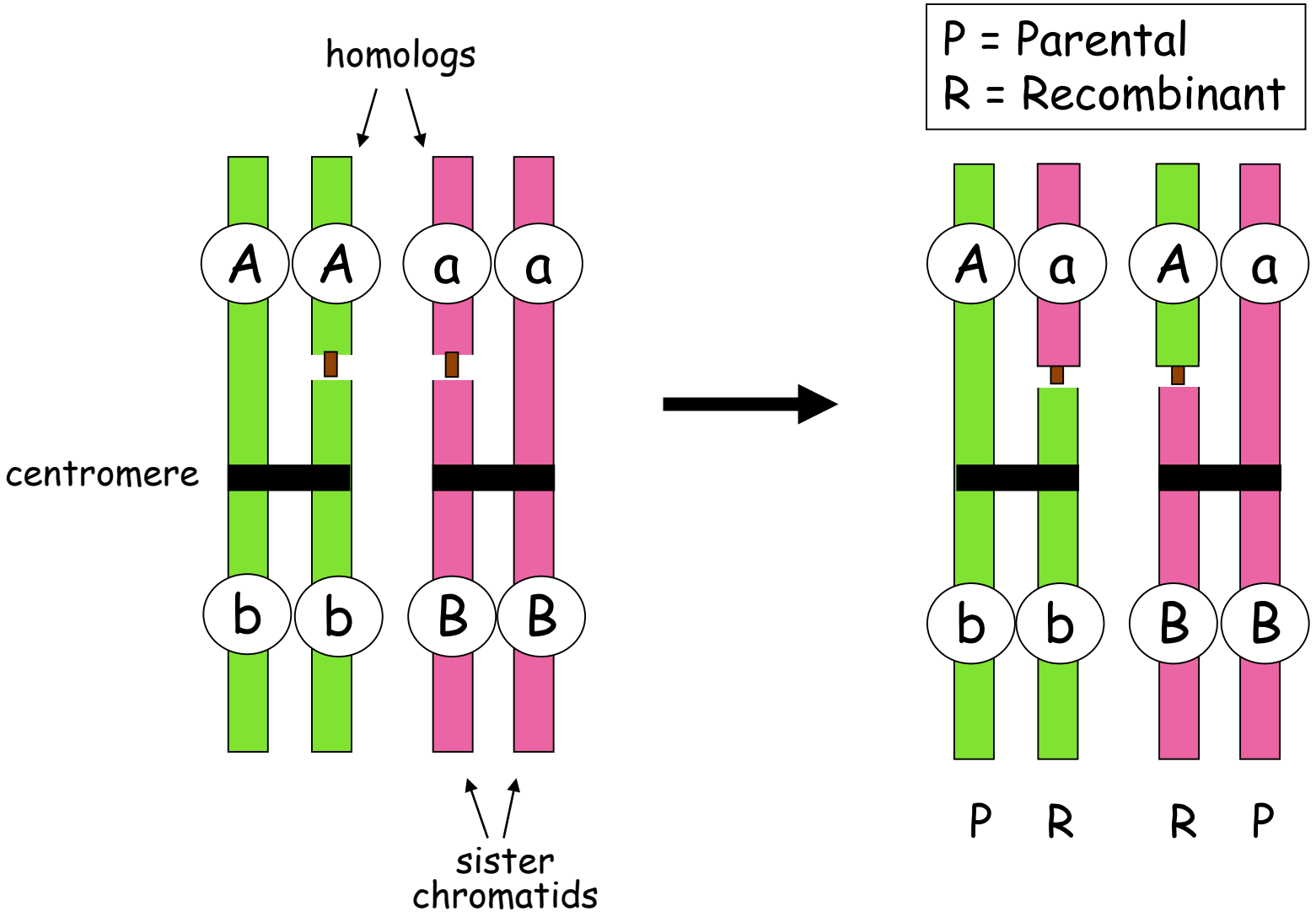


Using pool noodles to discuss crossing over and % recombinants

Locke & McDermid (2005) Genetics 170: 5-6



Pool noodles allow us to create many different cross-over events and see the consequences e.g. recombinant and non-recombinant chromosomes that will end up in gametes (egg and sperm). Below is one event:



Activation of Gene Expression

How do genes get "turned on" in response to signals? A skit of this 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:

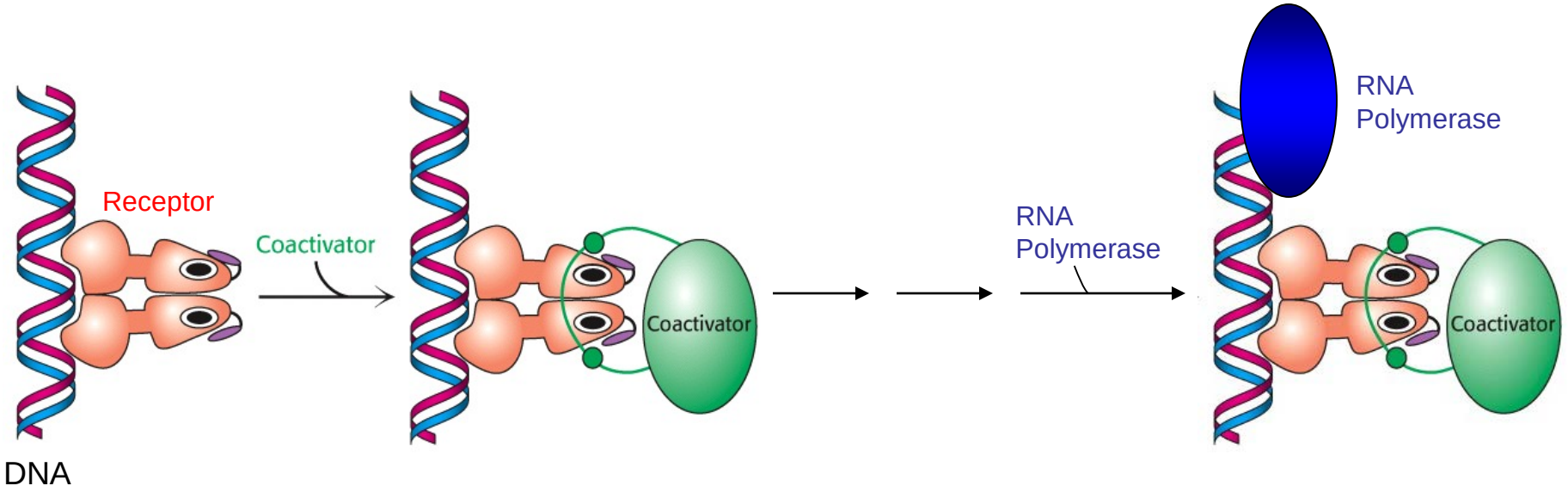
1) Steroids bind to proteins called "receptors".

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 start point of a gene and initiates transcription.

Scientists create cartoons



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

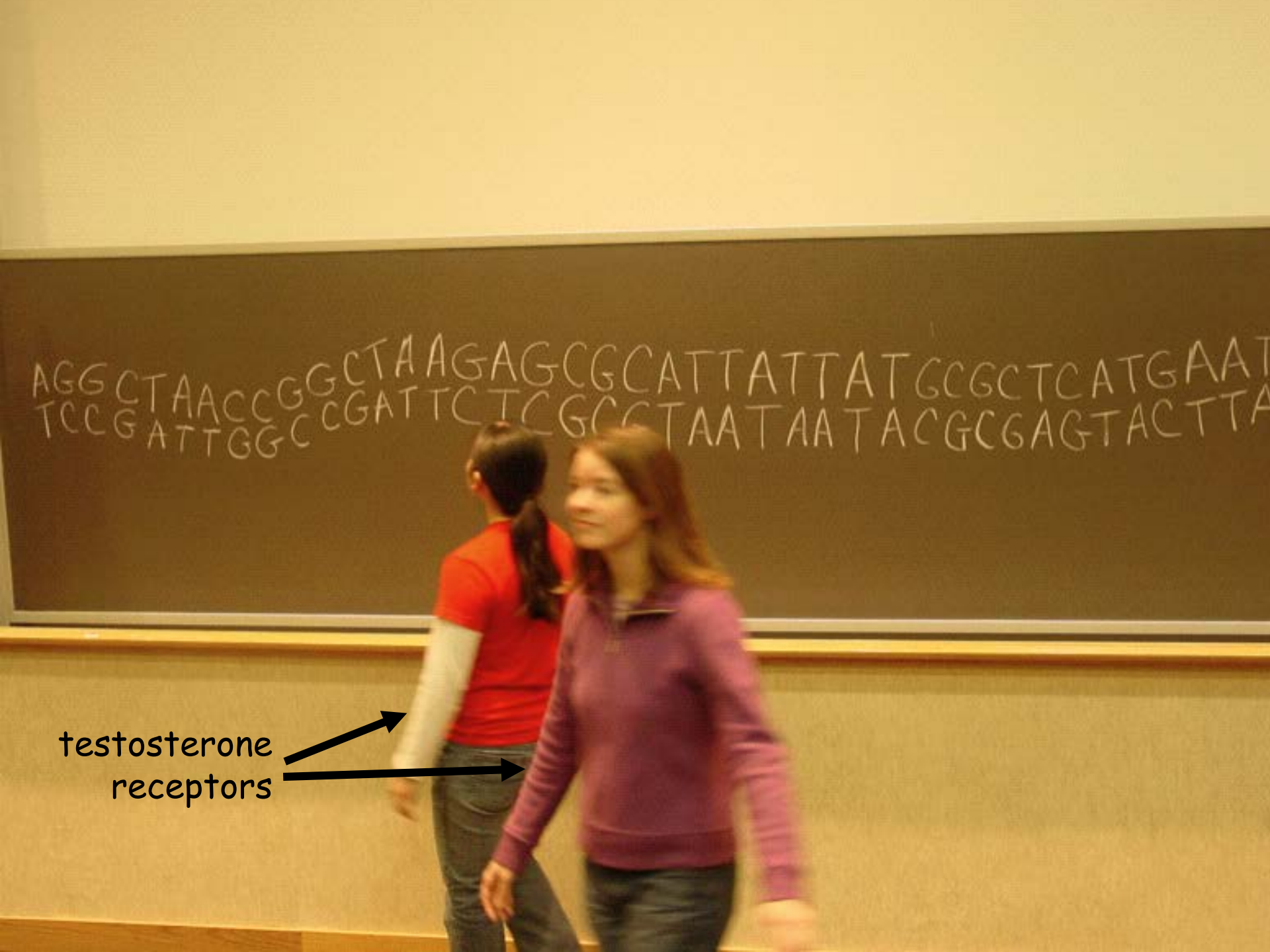
Using the proper sequence of events, act out the process of gene activation according to the following rules:

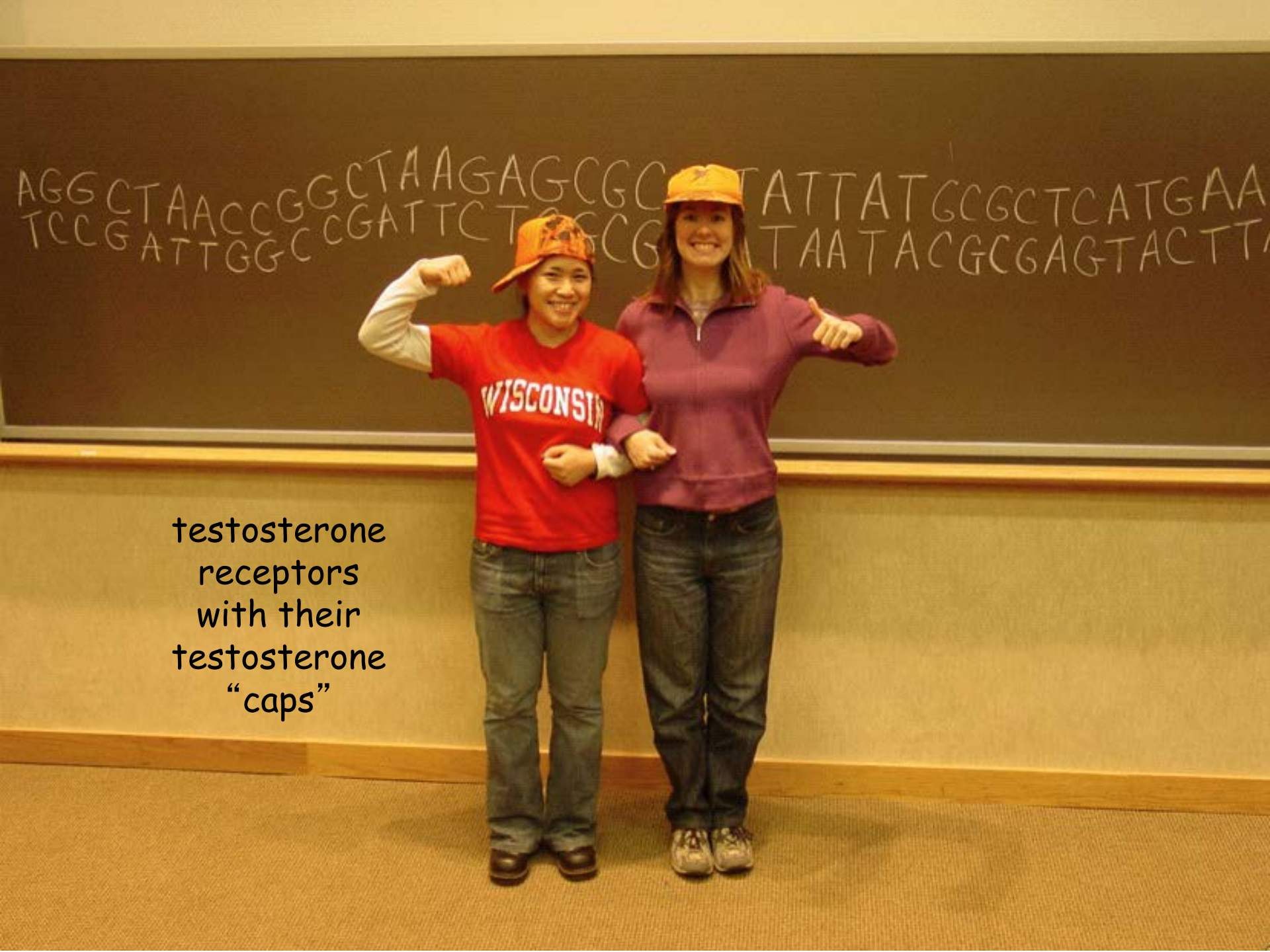
- Testosterone must be perceived.
- A gene with the following sequence must be found.

```
GAGCGCATTATTATGCGCTC
||||||||||||||||||||
CTCGCGTAATAATACGCGAG
```

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

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


testosterone
receptors


testosterone
receptors
with their
testosterone
"caps"


AGGCTAACCGGCTAA
TCCGATTGGC
TTATTATGCGCTCATG
AATAATACGCGAGTACTT


coactivator


RNA
polymerase


TATTATGCGCTCAT
TACGA
ATAATACGCGAG

Assessment:

All students were 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 do and don't understand.

2) Many students posed intellectually sophisticated questions, similar to those that scientists would ask.

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- scientific teaching
- 3 themes: active learning, inclusivity, assessment
- design teaching modules "backwards"
- put more responsibility for learning on students
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- Scientific teaching
  - teach classes the way we do research
  - inquiry-based, critical thinking, learning vs performing
  - work & learn in teams
- 3 themes
  - active learning (engage students in each class session)
  - inclusivity (teach to the diversity of students in a class)
  - assessment (how do the instructor & students know the students have met the learning objectives)
- Design teaching modules "backwards"
  - define learning objectives/goals (concepts & skills)
    -> then design assessments
      -> then design lessons
  - align assessments (and exams) with objectives
- Put more responsibility for learning on students
  - tell students what the learning objectives are and the outcomes that will show they have met the objectives
  - convey confidence in their ability to learn and succeed

My current "active learning" Genetics class

- 80-85 students instead of >200 students
- Each class session has clear learning objectives
- I cover some material in advance of class in Doceri movies (on YouTube)
- 30-50% of each class is group work (21 groups of 4)
  - Problems on in-class discussion sheets
  - Teaching team members (6 of us) circulate among groups
- Class sessions are multi-media: outline on document camera, some
  - PowerPoint slides, skits, tubs of pipe cleaners & beads
- Clicker questions for formative assessment during each class
  - I encourage group discussion
  - We discuss all answer options
- Assessments before and after
  - Chromosomes, mitosis, and meiosis
  - Genetics Concept Assessment from Smith, Wood & Knight
- The teaching team meets and strategizes each week

Let's keep sharing ideas and strategies via …

- webinars
- meetings (e.g. UC-FLC mtg at UCR)
- Summer Institutes
- skypes, calls & emails

My email is sstrome@ucsc.edu