Chromosome Shuffle

Pillar: Active Living
Division: IV
Grade Level: 12
Core Curriculum Connections: Biology 30

I. Rationale:

The Chromosome Shuffle is designed to clarify and reinforce understanding of the cellular processes of mitosis and meiosis, so that students will recognize the significance of each in living organisms. Role playing using giant models of chromosomes allows students of all ability levels to model the movement of chromosomes and the action of centrioles during replication and cell division. Physical movement and manipulation of the chromosomes and their parts in the process of cell division and replication both clarifies and reinforces some very abstract concepts for students.

II. Activity Objectives:

The students will be able to:

- illustrate the differences between the cell processes of mitosis and meiosis using physical movements.
- demonstrate a conceptually complex process by using a hands-on approach.
- replicate abstract concepts through role play and manipulation.

III. Curriculum Outcomes: Biology 30

Unit C: Cell Division, Genetics and Molecular Biology
General Outcome 1 *Students will* describe the processes of mitosis and meiosis.
Specific Outcomes for Knowledge *Students will:* 30–C1.2k explain, in general terms, the events of the cell cycle; i.e., interphase, mitosis and cytokinesis 30–C1.3k describe the process of meiosis (spermatogenesis and oogenesis) and the necessity for the reduction of chromosome number 30–C1.4k compare the processes of mitosis and meiosis 30–C1.5k describe the processes of crossing over and nondisjunction and evaluate their significance to organism inheritance and development

IV. Materials:

- see the attached diagram - these will make two homologous chromosome pairs of different lengths - quantity will depend on number of models constructed
- 4 wooden dowels - at least 1 foot long

- plastic tubing - 2 sizes - one that fits over each end of the dowel, a second larger tubing that will fit over the smaller tubing (the latter should be painted)
- nylon rope - two lengths - one to form a nuclear membrane - one to simulate the cell membrane (you may wish to have more than one cell in operation!)
- 4 velcro strips (3 inches each) - to glue around the center of each dowel
- 4 velcro strips (8 inches each) - for chromosome pairing - wrap around center of chromosomes
- 4 nylon cords (6-8 feet long) - for spindle fibers
- 4 latch hooks and 4 eyes - these will attach chromosomes to spindle fibers and permit them to be moved

V. Procedure:

*** Note:** Students require an initial understanding of the terminology and processes of mitosis and meiosis.

Preparation:

1. You will need to construct the chromosome models (two to three homologous pairs) prior to this activity. You need a large floor space (a classroom with the desks pushed to the sides of the room) for your "cell" and an appreciation of minor chaos and lots of noise as the students move about.

2. Gather supplies/materials from the local hardware store and construct large chromosome models. You will need at least two homologous pairs of different sizes, three would be even better. If you want, get several sets of materials and have the students construct the chromosomes and paint them. Colored tape can also be used to represent alleles on the chromosomes.

3. Class time required: one to two 50 minute periods. You may wish to discuss mitosis and meiosis on separate days.

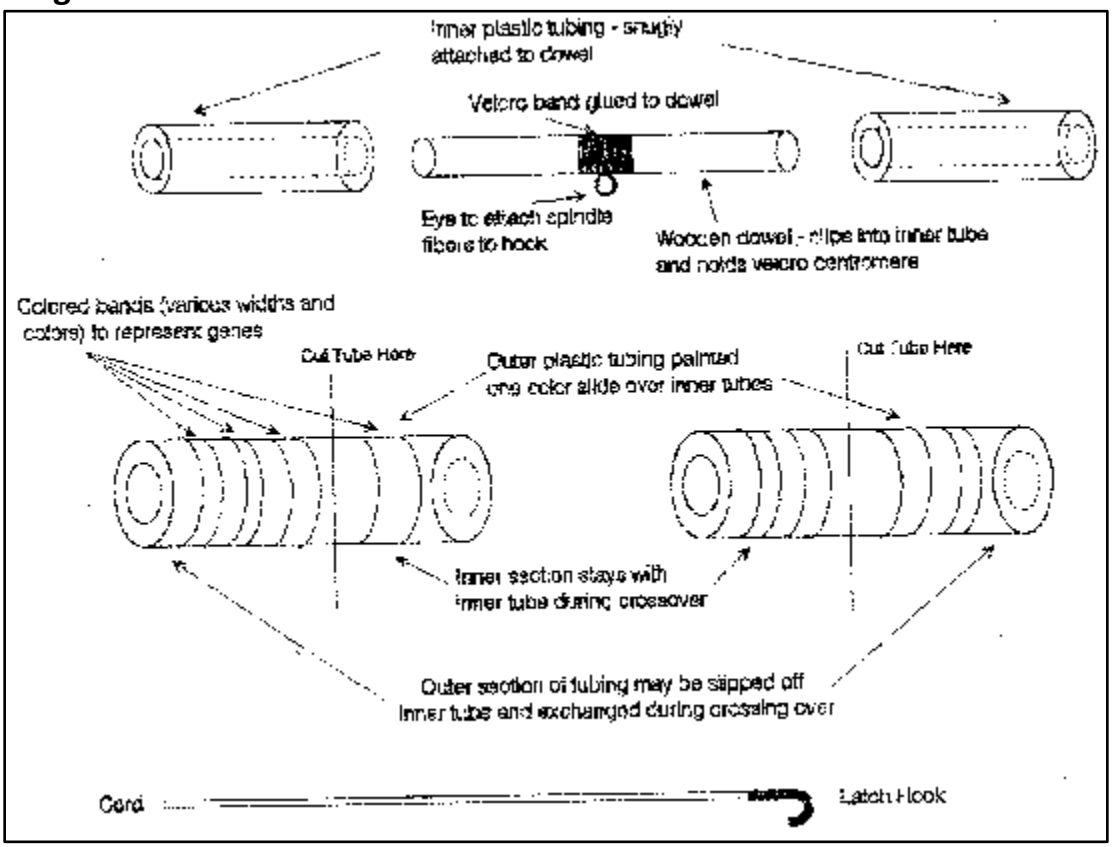
Activity: (demonstrates crossing over and gene linkage)

1. Create a "cell" by moving desks/tables to the periphery of room.
2. Designate 4 "chromosomes" - these students hold chromosomes, pair with homologs and exchange segments when crossing over.
3. Nuclear membrane - a rope on the floor around chromosomes - may be pulled away and reformed at appropriate times by one student.
4. Two students are "centrioles" - these students hold 2 nylon cords with latch hooks attached at one end. Before division these are hooked to eyes attached to the centromere on each dowel. During division, chromosomes may be moved along the floor to their new positions in the cell as division progresses. At the end of telophase, fibers are unhooked and new membranes reform around daughter nuclei.
5. Student participants change roles until entire class has participated.

VI. Extensions and Variations:

- This activity may be adapted to illustrate chromosome anomalies such as deletions trisomies, and other genetic events. Models can be used to show other mutation types as well as x-linkage. Each teacher will find new ways to use the models.

Diagram:


Inner plastic tubing - snugly attached to dowel
Velcro band glued to dowel
Eye to attach spindle fibers to hook
Wooden dowel - slips into inner tube and holds velcro centromere
Colored bands (various widths and colors) to represent genes
Cut Tube Here
Outer plastic tubing painted one color alike over inner tubes
Cut Tube Here
Inner section stays with inner tube during crossover
Outer section of tubing may be slipped off inner tube and exchanged during crossing over
Cord
Latch Hook