A PILOT DVD PROJECT

WHY THE Y?

EVOLUTION OF THE Y CHROMOSOME

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WHY THE Y?
Activity: Evolution of the Y Chromosome

Time Frame: One hour

Materials: Pop-it Bead Kit for genetics modeling (Wards 36-1600, DNA Simulation Kit), 1 copy of Student Instructions for each pair of students.

Teacher Directions:

Note: This activity is designed to aid students in understanding current ideas on the evolution of the Y chromosome as presented in animated drawings in the 4th lecture of the DVD "The Meaning of Sex". The activity focuses on students modeling the phenomena involved using pop-it beads so that their understanding of the DVD and lecture is more complete. It is strongly urged that students complete the activity on meiosis, which is part of this series, before beginning this activity. Students should also understand the inheritance of sex chromosomes and such common chromosomal errors as inversion, insertion and deletion before beginning this activity.

- Introduction
  - Discuss the inheritance of the X and Y chromosomes:
    - Ask the boys in the class whom they inherited their Y chromosome from. They should recognize that it is inherited from their fathers. If they fail to understand this, draw a simple Punnett square on the board or overhead to remind them of the inheritance of sex chromosomes.
    - Ask whom their fathers inherited their Y chromosome from (their fathers) and repeat for several generations.
    - Ask the girls who they inherit their X chromosomes from (students should recognize that girls inherit one X from their mothers and one X from their fathers.
  - Discuss the structure of the Y chromosome:
    - Ask students what is the difference between the X and the Y chromosome (students should recognize that in humans the Y chromosome is much shorter)
    - Remind them that this must mean that there are fewer genes on the Y chromosome (approximately 1000 genes on the X chromosome versus approximately 26 genes/gene families on the Y chromosome).
    - Ask students what they think is on the Y chromosome.
    - Play section 8 of Lecture 4 and pause on the cartoon so students can read it. Then play the next few minutes while the lecturer explains what each of the "genes" stands for.

- Watch chapter 10 of Lecture 4
  - Students take notes on the 3 classes of genes on the Y chromosome.
  - Point out to students that reptiles have no specific sex chromosomes (sex is determined by incubation temperature of the egg) but that humans do.
  - Explain that they are going to model the most recent theory of how this sex chromosome came about.

- Modeling activity
  - Work with students as they go through the modeling activity. If students become confused and have to begin again, point out to them that they can compare what is happening on the Y (right-hand) chromosome to the X (left-hand) chromosome that does not change.

- Bead models should appear as follows at the end of the activity:

  X chromosome

white	red
red	white
red	green
white	blue
red	white
white	
red	
white	
white	
pink	
white	

- After students have completed the activity, play DVD chapters 11 through 15 for them.

Evaluation:

- Have each student write a short paragraph explaining the evolution of the Y chromosome starting with a pair of autosomal chromosomes (proto X and proto Y) containing the SOX 3 gene.

Web Connection: http://www.biology.arizona.edu/human_bio/human_bio.html

Student Directions: Evolution of the Y Chromosome

Modeling the X and Y chromosomes:

Using your bead kits make two separate strands of pop-it beads with the following order:

Proto-X strand	Proto-Y strand
white	white
red	red
red	red
white	white
red	red
white	white
red	red
white	white
white	white
pink	pink
white	white

These represent the two autosomal (body) chromosomes, which will evolve to become the sex chromosomes. The strand on the left represents the proto-X chromosome while the strand on the right represents the proto-Y chromosome. The beads represent separate genes. The pink bead represents a gene called SOX3, the precursor to the testes producing gene, SRX.

Notice that these two chromosomes can exchange genes through crossing-over and still have the same genes although the alleles may be different. Prove this to yourself by crossing the two chromosomes over and exchanging the last four beads on each strand.

The first major evolutionary event that occurs is that the SOX3 gene on the proto-Y (right-hand) chromosome mutates to become the SRX gene (the testes forming gene). Model this by changing the pink bead on the right-hand strand to a blue bead.

The next event is an inversion of the genes on the proto-Y chromosome. Model this by removing the bottom four beads on your right-hand strand and placing them on the top of the strand. This produces one type of genetic error. Notice that now the chromosomes can no longer exchange genes or they will end up with duplicates of some genes and will lack other genes. Prove this to yourself by crossing over and exchanging the last four beads on your two chromosomes. How many red genes did the left-hand chromosome end up with? What happened to the pink and blue genes? Return the last four beads to their original chromosomes.

Because the chromosomes can no longer exchange genes, errors such as deletions tend to occur. These problems tend not to occur in the X chromosome (left-hand strand) because it can still exchange genes with other X chromosomes when it occurs in females. Model these deletions by removing the third and fourth white bead (starting from the top and counting down) on the proto-Y (right-hand) chromosome.

Model a further inversion and deletion by removing the bottom three beads of the proto-Y (right-hand) chromosome and placing them on top of the chromosome. Remove the last two red beads.

Occasionally copies of genes from other chromosomes are added in to the proto-Y chromosome. Model this by adding a green bead after the second red bead on the right-hand strand. This represents the DAZ gene which is involved in sperm production and which was originally on an

autosomal chromosome. Further deletions of genes occur so remove the 2nd and 3rd white beads and the 2nd red bead on that strand. How many genes (beads) are left on your Y (right-hand) chromosome? How many genes are found on your X (left-hand) chromosome?

After watching the section on the evolution of the Y chromosome on the DVD, write a short paragraph explaining the evolution of the Y chromosome sometime in the distant past from an autosomal chromosome to its current size.