Genetics of Sesame Street ™ Characters

by Susan Raye

At the end of every year I ask my eighth grade students what their least favorite topic was. Every year, until now, their unfailing answer has been genetics and inheritance. Because tongue-rolling and ear lobes have a limited appeal, and genes and chromosomes are just too abstract, I looked for a model that would be attention-catching, colorful, and fun, yet not too different from "real" humans. As a result, this year, with the help of Elmo, Zoe, Grover, and friends, the genetics unit has moved onto the favorite list. In this week-long unit, the students

- create a gene map for a particular Sesame Street character,
- move the resulting chromosomes through the steps of meiosis to produce the possible gametes of that individual,
- choose a spouse and diagram the genetic crosses that would produce two different children, and
- draw family portraits based on the genotypes of each individual.

Introducing the unit

I begin the lesson with five stuffed Sesame Street beanbag dolls: Elmo, Zoe, Grover, Telly, and Honker (see Resources). I ask the questions: "What if Zoe and Elmo fell in love, got married, and had a baby? What would their


One student's Sesame Street family

PHOTOS COURTESY OF THE AUTHOR

baby look like?" This leads to a lively discussion during which I ask, "Why do children look like their parents? Why do children have some traits of each parent? What exactly do parents pass to their children? How do parents pass traits to their children?" These guiding questions are directly related to the content standards Structure and Function in Living Systems and Reproduction and Heredity for grades 5–8, as described in the *National Science Education Standards*.[1]

I ask the students to carefully study the Sesame Street beanbag dolls and write down all of the traits that could be passed from parent to child. Then we write all observations on the board and distinguish between a trait and specific forms of the trait. For example, body color is a trait that may be passed down, but there are six different forms or colors of this trait (see Figure 1). Next I

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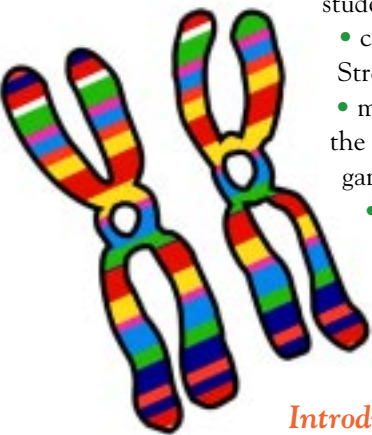
Is Grover's baldness a dominant trait?

use the gene map of *Sesamus muppetis* (see activity sheet, page 15) to introduce and define the terms *chromosome, gene, allele, karyotype, sex chromosomes, gene map, homozygous,* and *heterozygous,* as well as the concepts of *homologous pairs* and *species specific chromosome numbers.* We also discuss the term *heredity* and different ways that alleles can interact: *dominant, recessive,* and *incompletely dominant.*

Students often have a difficult time grasping that alleles are different forms of one gene, so it helps to have many examples from both human and Sesame Street populations. Figure 1 shows five characteristics of Sesame Street characters, the alleles for each characteristic, and the type of inheritance of each. I purposely choose traits that humans share, and I mention human examples and parallels frequently throughout the unit (e.g., eye color, sickle cell anemia, blood types, and male-pattern baldness).

Creating a gene map

At this point, the students are ready to get their hands on the Sesame Street beanbag dolls and determine exactly what is passed on to the next generation. I give each group a set of the beanbag dolls and a copy of the Genetics of Sesame Street characters table (Figure 1). Each group determines the phenotypes and genotypes of each trait for each Sesame Street character, then each student chooses a favorite Sesame Street character and maps his or her specific genes, using the activity sheet on pages 15–16. The students literally can now see the relationships between alleles, genes, and chromosomes.

Production of gametes

The next question is, "How are these genes passed on to the next generation?" Students model the production of eggs and sperm by cutting out their paper chromosomes and moving them through the steps of meiosis. Most genetics units have a version of this activity using pipe cleaners or colored yarns. When the students use the chromosomes they make in this activity, which show the alleles for each trait, it is much easier for them to follow the mechanics of meiosis. They understand exactly what gametes that individual will produce. Once they have successfully produced the four gametes, it is important that they tape or copy the chromosomes onto drawings of four cells. The students can't help but notice that not all gametes of an individual are the same, and that males make X sperm and Y sperm but females only make X eggs.

Passing the genes to the next generation

I begin this section with stories of how the Sesame Street characters grew up, fell in love, got married, and had families of their own. Each student then goes around the room to find a spouse for his or her character. Then, randomly choosing egg and sperm from those created in the meiosis activity, they draw out the genetic crosses for two different children (see activity sheet, page 17). As a culminating activity, I have them each draw family portraits. This requires a clear understanding of sex determination; multiple
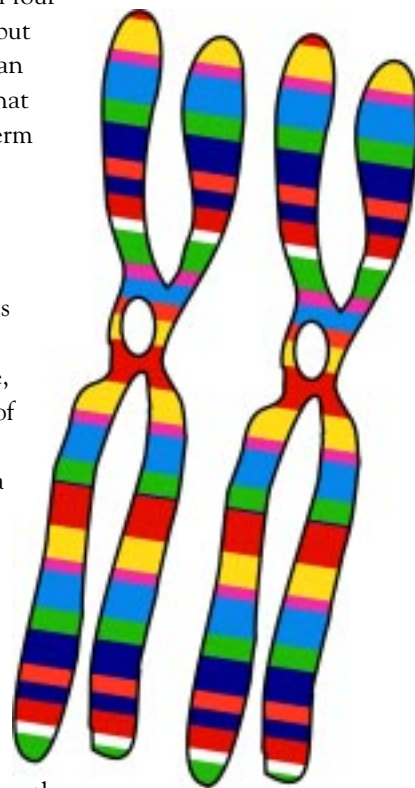
What is Zoe's eye shape genotype?

Assessment

Because each step depends on the previous step in this activity, assessment of student understanding must be checked daily. I do this by
• visually inspecting their chromosome maps before allowing them to begin meiosis;
• having each group demonstrate meiosis to me and explain the different products before they are allowed to look for spouses; and
• checking the chromosomes of the two children before they begin the portraits.

The final piece that each student hands in for a grade is the portrait with the diagram of the two crosses. I grade the portraits according to how accurately they portrayed the genetic characteristics of each individual, as determined by their genotypes. I hang the portraits in the room— the students love to study these in their free time, often debating the accuracy or probability of various combinations.

alleles; and dominant, recessive, and incompletely dominant alleles. As the students draw and color, they learn why family members sometimes share traits, and sometimes look so different. They also see why sex-linked traits show up on males who only have one recessive allele; they discover that females can be bald; and they realize that the sperm of the father determines the sex of the child.

| Figure 1	Genetics of Sesame Street characters		
Characteristic	**Phenotype**	**Genotype**	**Type of inheritance**
Eye shape	exo (pops out)	EE, Ee	dominant/recessive
	endo (flat)	ee	
Nose color	pink	PP, Pp	dominant/recessive
	orange	pp	
Lip color	magenta	MM	incomplete dominance
	red	Mm	
	purple	mm	
Body color	red	RR	multiple alleles: R, B, & O
	purple	RB	incomplete dominance
	yellow	RO	
	blue	BB	
	magenta	BO	
	orange	OO	
Hair type	hairy	HH, Hh	dominant/recessive
	bald	hh	sex linked

Sesame Street genetics activity

Introduction
Much is known about the genetics of *Sesamus muppetis.* Karyotyping reveals that Sesame Street characters have six chromosomes: two homologous pairs and one pair of sex chromosomes. Chromosome pair #1 is the largest and has a centrally placed centromere. Chromosome pair #2 is much shorter with the centromere at one end. Sex is determined by X and Y chromosomes just as it is in the related species, *Homo sapiens.* Through the process of gene mapping, geneticists have found the specific locations of the genes for eye shape, nose color, lip color, body color, and hair type. By observing the offspring of many crosses, geneticists also have determined the types of inheritance that several of these genes exhibit.

Gene Map

Chromosome #1   Chromosome #2   X chromosome   Y chromosome

Eye shape →

Body color→

← Lip color

← Hair type

Nose color →
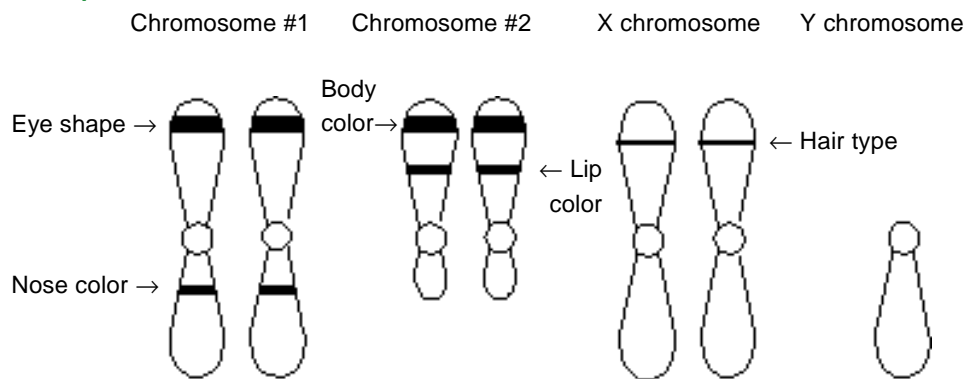
Objectives
In this lab you will determine the genotypes of five Sesame Street characters, and map the known genes for one individual.

Procedure
1. For each Sesame Street character, describe each of the traits on the table on the next page.
2. Use the Genetics of Sesame Street characters table (Figure 1) to determine the genotype, or possible genotypes, of each Sesame Street character for each trait based on each character's phenotypes. Add these to the phenotypes and genotypes table on the next page.
3. Answer the questions that follow the table on the next page.
4. Using the gene map above, choose one Sesame Street character and write in his or her specific alleles on the karyotype on the next page. Remember that each chromosome has only *one* allele for each gene. When the individual has the dominant phenotype, you have the choice of making him or her heterozygous or homozygous for that trait.
5. Copy these alleles exactly onto the second set of chromosomes.
6. Cut out all the chromosomes and move them through the steps of meiosis.
7. Draw four cells and tape or copy the products of meiosis onto these cells.
8. Save these cells in an envelope for use in the next activity.

Sesame Street genetics activity (continued)

Phenotypes and genotypes table

	Eye shape	Nose color	Lip color	Body color	Hair type
Grover					
Elmo					
Zoe					
Telly					
Honker					

Questions

1. Which chromosome carries the gene for nose color? _____

Is the gene for nose color on the same place on the same chromosome for all Sesame Street characters? _____

Which nose color phenotype is dominant? _____

List the genotypes that would result in a pink-nosed individual. _____

2. How many body color phenotypes are in the Sesame Street population? _____

How many forms of the body color gene are in the Sesame Street population? _____

How many genes for body color does any one individual have? _____

How many different forms of the gene for body color could an individual have? _____

3. What sex chromosomes do all males have? _____ all females? _____

Sex chromosomes determine the sex of an individual. Do they have genes for any other traits as well as sex? _____

If a female had the H allele on one X, and the h allele on the other X, would she be hairy or bald? _____
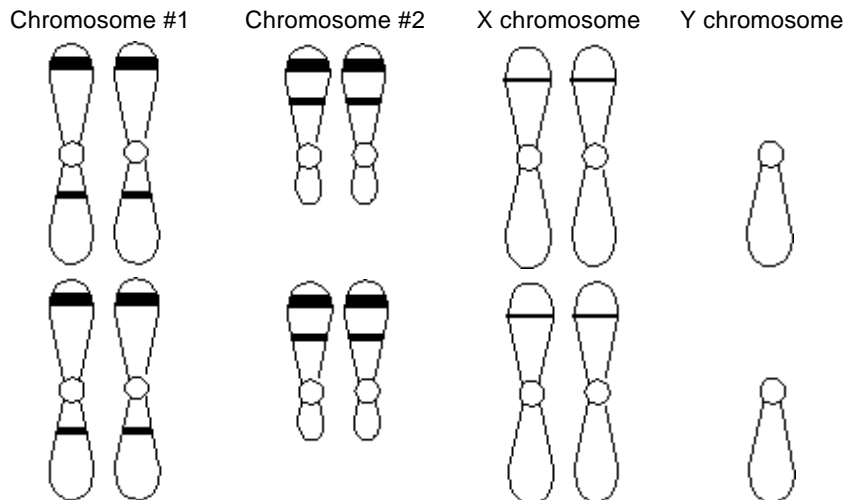
Is there an allele for baldness on the Y chromosome? _____

If a male had the h allele on the X, would he be hairy or bald? _____

Karyotype

Name of Sesame Street character: _____

Sex: _____ Sex chromosomes: _____ (cross out the extra X or Y below)

Chromosome #1   Chromosome #2   X chromosome   Y chromosome

References

1. National Research Council. 1996. *National science education standards*. Washington, D.C.: National Academy Press.

Resources

Sesame Street beanbag dolls can be purchased at toy and department stores for approximately $4.95. As alternatives, you can ask students to bring their own in; or, if students have a sewing class or an art class, they may be able to make their own Sesame Street characters out of cloth, papier-mâché, or ceramic.

Can you see incomplete dominance in this family?

Sesame Street characters: The next generation

Procedure

You have created a gene map of a particular Sesame Street character and have identified all possible gametes that he or she could produce. Today you will choose a spouse for your character, then you will determine what two of their children will look like.

1. Choose any two gametes from your individual and draw the chromosomes in the appropriate cells below. Show the specific alleles in the correct locations.

2. Choose a spouse for your character, find a classmate who has that character, and copy any two gametes in the appropriate cells.

3. Draw the chromosomes, with specific alleles, of the fertilized egg.

4. Use the Genetics of Sesame Street characters table (Figure 1) to find the phenotypes of the two children.

Egg from _____ fertilized by sperm from _____ produces child: