Activity 1: 1 in 4000

Based on video content

15 minutes

Setup

One in approximately 4000 babies is born with intersexuality. In this condition, gender cannot be determined by a visual examination of the genitals. The video for this unit explores the biology of gender and some of the variations that can occur in gender development. Before watching the video, spend a few minutes in pairs, thinking of all the details you can recall about how gender is determined in humans. Then brainstorm as many different causes as you can think of for abnormalities in gender development, either in humans or in other animals. Finally, as a group, collect and categorize the causes you came up with and the effects they would have. Tips and Suggested Answers lists some ideas that your group may have thought of.

Materials

- Tips and Suggested Answers

Potential Answers

A few causes your group may have thought of are:

1. abnormalities of entire chromosomes
    a. missing chromosomes

        XO (Turner's syndrome, result is female development with some mental and physical differences)

    b. extra sex chromosomes
        i. more than two X (XXY, XXX, etc): viable, although more than two X chromosomes causes some physical differences and any Y causes mostly male development
        ii. more than one Y(XYY etc): viable as long as there is an X; results in male development

2. abnormalities of parts of chromosomes or defects in single genes on sex chromosomes
    a. translocation of parts of Y to X (or another chromosome)

        inheritance of the male-determining gene SRY causes mainly male development, although some abnormalities can result if there is only the SRY gene without the rest of Y

    b. mutations in single genes on Y

        depending on the gene, can cause male development with sterility or other effects; or if SRY is affected, can cause female development, even though a Y chromosome is present

3. single gene mutations on non-sex chromosomes
    a. defects in hormones, receptors, or enzymes can cause syndromes like androgen insensitivity, in which an XY develops as a female

4. other
    a. some people may know about "freemartins" in cows: if a cow has twins, one male and one female, the female will be sterile because of the hormones produced by the male during their in utero development

Activity 2: Birds Do It, Bees Do It

Based on video content

15 minutes

Setup

Biology has a variety of ways to create different genders. In pairs, take a few minutes to brainstorm as many different sex-determination mechanisms as you can think of. Use specific examples if you can think of any. Then, as a group, list all the different mechanisms the pairs thought of and categorize them. Tips and Suggested Answers lists some ideas that your group may have thought of.

Materials

- Tips and Suggested Answers

Potential Answers

A few different mechanisms that your group may have thought of are:

1. chromosomal determination
    a. Humans and other mammals have XX females and XY males. In humans, the gene *SRY* on the Y is primarily responsible for male development.
    b. *Drosophila* fruit flies also have XX females and XY males, but sex is not determined by a specific gene on one of the sex chromosomes; it is determined by the ratio of X chromosomes to autosomes (non-sex chromosomes). In *Drosophila*, an X:autosome ratio of 1:0 is a female, so a diploid set of autosomes and XX is female. An X:autosome ratio of 1:2 is male, so a diploid set of autosomes and XY is male. Therefore, in humans, XO is a female; in *Drosophila*, XO is a male. In humans, XXY is male; in *Drosophila*, XXY is female.
    c. In birds, males are the homogametic sex, meaning one type of sex chromosome, with the ZZ combination; females are heterogametic (or heteromorphic) with ZW.
    d. Some, but not all, plants that have separate male and female plants (dioecious) have an XY sex chromosome system.
    e. In *Caenorhabditis elegans*, a soil worm used in genetic and developmental research, most individuals are hermaphrodites with two X chromosomes. Rare males are XO.
    f. In some insects, like grasshoppers, females are XX and males are XO.
    g. In bees and some other insects, males come from unfertilized eggs so they are haploid (one set of chromosomes). Females come from fertilized eggs and are diploid (two sets of chromosomes).
2. environmental cues
    a. In turtles and some other reptiles, temperature of the egg during development determines male or female development.
    b. In some fish, the presence of other males and females determines sex. If the group loses a male, a female will change gender and become a male.

Activity 3: What About Meiosis?

Based on video and online text content

15–30 minutes, depending on the experience of the participants

Setup

The sex chromosomes represent a special situation in meiosis. In meiosis I, autosomes pair with their homologs, cross-over, and segregate. The pairing and crossing-over is an essential step; meiosis cannot proceed without it. However, in an XY male, the X and the Y do not have a homologous chromosome with which to pair. So what do they do?

Homologous chromosomes are necessary for repairing damaged chromosomes. Every time an X chromosome finds itself in a female, it has a chance to repair mutations from a homolog; however, the Y chromosome is nearly always by itself because a normal male is XY. So how does the Y undergo recombinational repair?

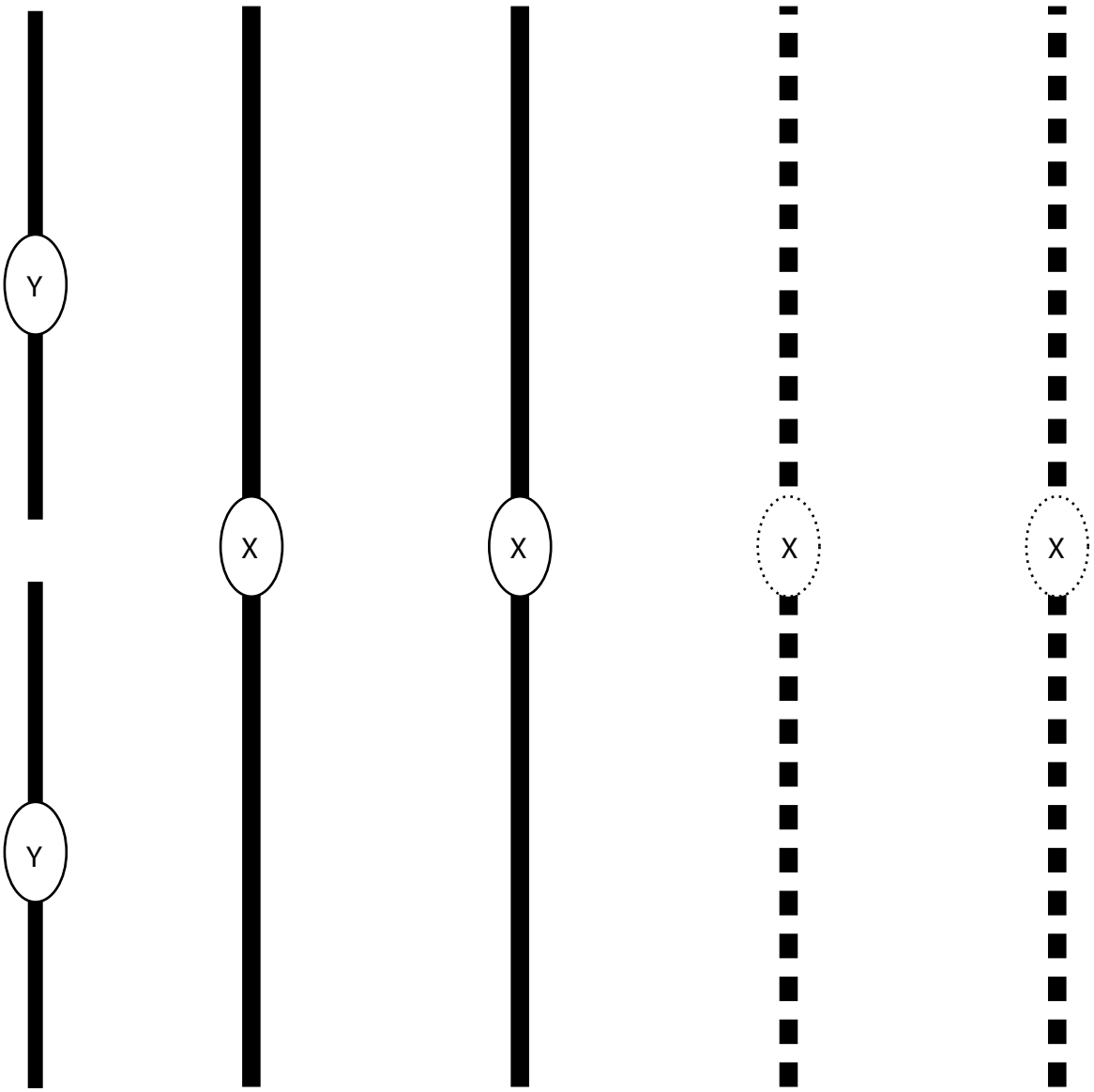
Although someone with a sex-chromosome abnormality may be infertile, there may still be germ line cells that go through meiosis—even if viable eggs and sperm are not produced. What happens if there are extra sex chromosomes or missing sex chromosomes?

We often do labs or demonstrations of meiosis using pipe cleaners or pieces of paper to represent chromosomes; we can use them here to show some of the exceptional meiotic situations of the sex chromosomes. Work through each situation in pairs. If you are used to working with demonstration chromosomes in this way and don't want a warm-up, you can skip the first few exercises.

Materials

- One set of Paper Chromosomes per two people (master copy provided; to make a set, cut after copying, so that each chromosome is separate)
- One copy of the Instructions and Situations per two people (master copy provided)
- A box of small- to medium-sized paper clips
- A roll of tape
- Tips and Suggested Answers

Paper Chromosomes



Instructions and Situations

For answers, see Tips and Suggested Answers.

Instructions:

Make sure your chromosomes have been cut so that each chromosome is separate. To make duplicated sister chromatids, paper-clip them together at the circle, which represents the centromere. There are four copies of autosome 1, so you can make paired, duplicated chromosomes during meiosis I. For meiosis II, remove the paper clips binding the duplicated chromosomes to show how they will separate, and what combinations of chromosomes can end up in the gametes.

There are four copies of X and two of Y, so all the situations can be represented. The arrows on one of the Y chromosomes show palindromic sequences needed for Situation 5.

Situation 1: Normal male
(A warm-up, so skip this one if you are used to showing X and Y segregation using demonstration chromosomes.)

To warm up and get used to using the paper chromosomes, show meiosis I and meiosis II using the sex chromosomes and one autosome from a normal male. For the autosomes, take one solid-line and one dotted-line version of chromosome 1. What is the probability of a gamete with a Y chromosome and a "dotted" chromosome 1?

Situation 2: Androgen Insensitivity Syndrome (AIS)
(A warm-up, so skip this one if you are used to showing X and Y segregation using demonstration chromosomes, and determining probabilities of segregation outcomes.)

A person with this condition is XY. The recessive mutation that causes AIS is on the X chromosome. Show all the relevant chromosomes pairing and then segregating in meiosis I; then show the sister chromatids separating in meiosis II. If a person with AIS was not infertile, what would be the chances that they would pass on a chromosome with the AIS mutation?

Situation 3: 45, XO (Turner syndrome, O stands for no other sex chromosome)
(A warm-up, so skip this one if you are used to showing X and Y segregation using demonstration chromosomes, and determining probabilities of segregation outcomes.)

In a person who is XO, there is only one X chromosome. Show what you think happens in meiosis I and II. What are the chances of a gamete that, if fused with normal sperm from a male, would result in the Turner syndrome genotype? What are the chances of an inviable zygote?

Situation 4: 47, XXY (Klinefelter syndrome)
Show what would happen to the sex chromosomes during meiosis of a cell that was XXY. What are the chances of a gamete that, if fused with normal gametes from a female, would result in the Klinefelter syndrome genotype?

Situation 5: X and Y
When the sequence of the Y chromosome was determined, investigators discovered that it contained several palindromic repeat sequences. These are regions with similar sequence but oriented in the opposite direction. The investigators suggested these regions could be used for recombinational repair by the Y chromosome, essentially allowing the Y chromosome to undergo crossing over with itself.

Start by showing exactly how the X and Y pair during meiosis and where crossing over can occur. What conformation does the X chromosome have to assume?

Next, use the Y chromosome with the white arrows to show how Y can use its palindromic regions to undergo recombinational repair. What conformation does it have to assume?

Situation 6: 46, XX male

Some males have two X chromosomes, but with part of the Y chromosome translocated onto one of the X's. The translocation mutation may occur during meiosis in the father of the 46, XX male. The father would be normal XY, but would produce a sperm that, when combined with an egg, produced the 46, XX male genotype.

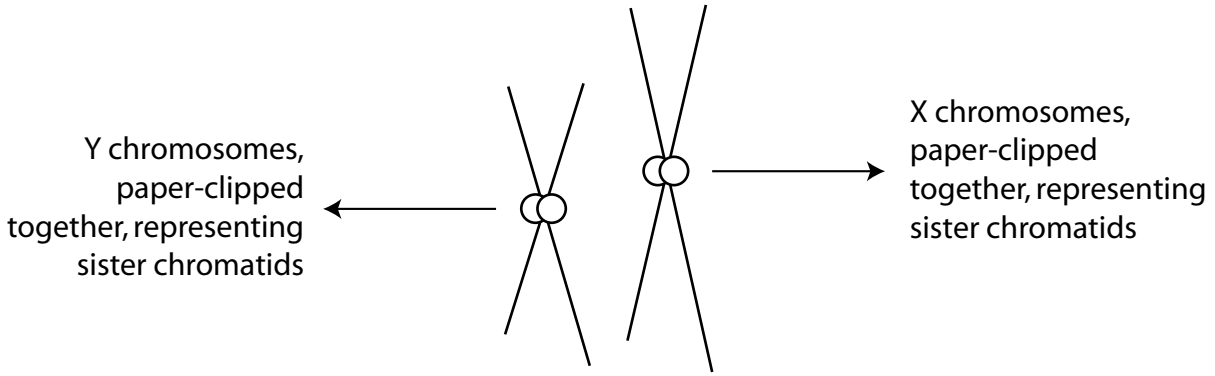
Start with the normal XY chromosome combination, as they would be in meiosis I. Show how the translocation would occur by ripping off a little bit of one Y chromatid, transferring it to one X chromatid, and then securing it with tape. Then show how the rest of meiosis would proceed. What gametes are produced in the end? What part of Y has to be translocated in order to direct male development? Because translocations often occur through errors in crossing-over—and you have shown in Situation 5 how X and Y cross-over in meiosis—where do you think the critical part of Y is located?

Answers

Situation 1:
The chance of gamete with Y is 1/2. The chance of a dotted chromosome is 1/2. 1/2 x 1/2 = 1/4.

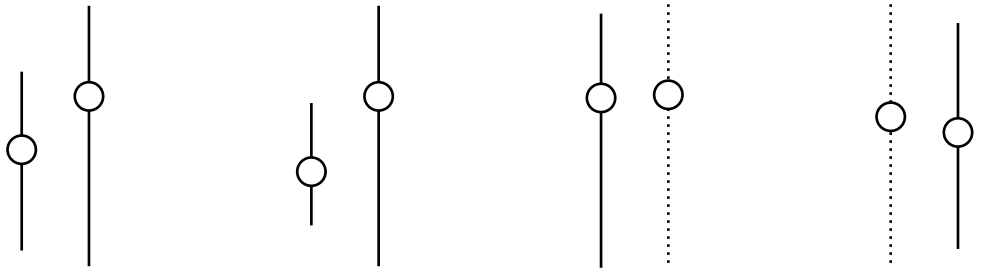
meiosis I

duplicated X and duplicated Y pair and then segregate, just like the homologous autosomes, even though they are not true homologs



meiosis II

sister chromatids separate
(Of course, independent assortment says these are not the only combinations of chromosomes that are possible!)



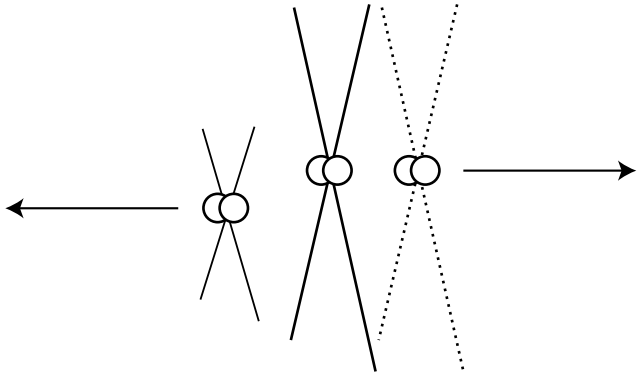
Situation 2:
Diagrams look like the sex chromosomes in Situation 1, but both copies of the X carry a recessive AIS allele, so the chance of a gamete with this allele is 1/2.

Situation 3:
In meiosis I, there is no X or Y for the duplicated X to pair with; it segregates to one cell or the other. So at the start of meiosis II, one cell is normal and the other will give rise to two gametes with no sex chromosomes.

The chance of a gamete with no sex chromosome is 1/2. Gametes from a male would have either an X or a Y. In order to result in a zygote with the Turner syndrome genotype, a gamete with no sex chromosome would have to fuse with a sperm with an X. The chance of a gamete with no sex chromosome from the XO person is 1/2. The chance of a sperm with an X is 1/2. 1/2 x 1/2 = 1/4.

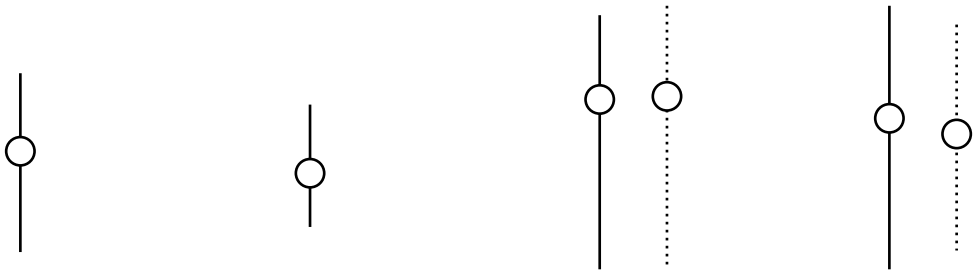
At least one X chromosome is essential, so an inviable zygote would result from the fusing of a gamete with no sex chromosome with a sperm with a Y. The chances are 1/2 x 1/2 = 1/4.

Situation 4:
XX and Y all pair, so meiosis I looks like this:



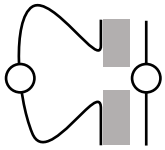
During segregation, the two duplicated X's could go into one cell, with the duplicated Y segregating into the other. Alternately, an X and a Y could segregate together into one cell, with the other X segregating into the other cell.

In meiosis II, sister chromatids segregate; a cell that had received two, duplicated sex chromosomes would divide into two cells, each with an extra sex chromosome. Here's one possibility for the end of meiosis II: If the chromosomes shown during meiosis I segregated so that the two duplicated X's segregated away from the Y, the end of meiosis would produce two gametes that each have 1Y, and two gametes that each have 2 X's.

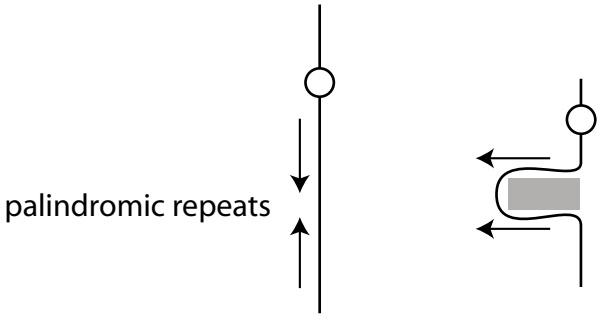


The XXY cell would produce the following gametes (with the X's marked so they can be followed separately): X^1, Y, X^2, X^1Y, X^1X^2, X^2Y. Normal gametes from a female would all contain one X. The probability of a XY gamete from an XXY person is 2/6. 1 x 2/6 = 2/6 = 1/3.

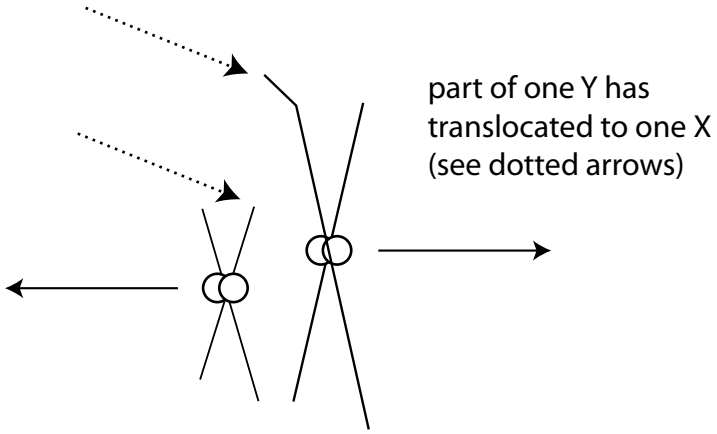
Situation 5:
The Y chromosome is much shorter than X, yet the homologous regions that pair and cross-over are at the ends of the chromosomes. Therefore, the X chromosome has to assume a looped conformation to pair with Y in meiosis. Crossing-over can occur in the shaded area.



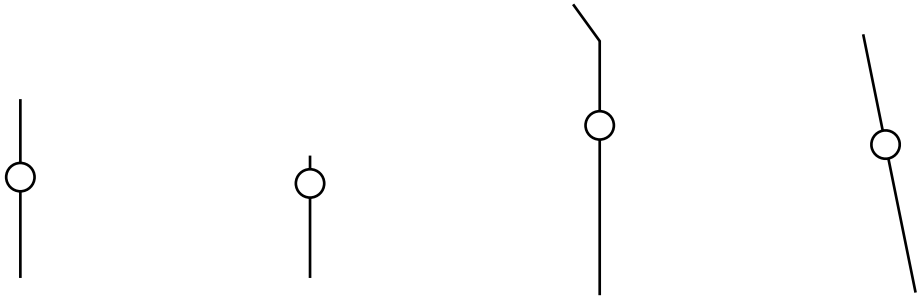
If the Y chromosome uses its palindromic repeat sequences to undergo recombinational repair, the sequences have to align along their homologous (or similar) regions. A conformation like this would have to occur. As above, regions where crossing over can occur are shown in gray.



Situation 6:
In meiosis I, after the translocation, the chromosomes would look like this:



After meiosis II, they look like this:



As long as all the autosomes segregated correctly, there are two completely normal gametes: one with a X and one with a Y. There are two abnormal gametes—one with an X that has a portion of Y. If this portion contains the gene SRY, which determines maleness, this chromosome will direct male development. In fact, the SRY gene is located toward the end of the Y chromosome, close to the region where crossing over occurs with X. A slight misalignment of X and Y in meiosis can transfer SRY, and possibly more of Y to the X chromosome. The extent to which the development produces a normal, fertile male depends on how much of Y was translocated. The other gamete has a Y that is missing a segment. The viability and gender of a zygote from this sperm depends on how much of Y is missing.

Activity 4: What Are Our Roles?

Based on video and online text content

30 minutes

Setup

One of the ramifications of gender assignment is how parents, teachers, counselors, and school administrators will treat intersex children. In 2001, the television show *Friends* offended the Intersex Society of North America by treating this situation comically. Guest star Brad Pitt played a former high-school colleague who made up a rumor that Jennifer Aniston character was intersex.

In real life, the issue can create difficult situations, which this exercise will explore. Working in teams of three or four, choose at least three different roles to explore—such as mother, father, doctor, principal, the child's teacher, the school counselor, or the child. Suggested topics for role-playing or discussion are listed below. Choose either a situation in which parents are first confronted with the birth of an intersex child, or a situation in which the child has grown and is adjusting to life in school. If a school situation is chosen, each group can choose the grade they have the most experience with, or different groups can portray the same situation at different grade levels.

As a group, discuss afterwards how the viewpoints of different parties varied or were the same. Were there some fundamental principles or ground rules that everyone agreed on?

Materials

- One copy of the Situations and Discussion Topics per person (master copy provided)

Situations and Discussion Topics

1. How might a health care professional approach parents who will give birth to, or have given birth to, an intersex baby? How might the parents react, what might their options be, and how would they make their decision?

   For this situation, it might help to read the position of the Intersex Society of North America as of 2003 (http://www.isna.org):
   - Intersexuality is basically a problem of stigma and trauma, not gender.
   - Parents' distress must not be treated by surgery on the child.
   - Professional mental health care is essential.
   - Honest, complete disclosure is good medicine.
   - All children should be assigned as boy or girl, without early surgery.

2. How might a teacher introduce a child of ambiguous gender in a classroom, at several grade levels? What might we tell students who notice that a student is different and treat them differently, or ask about him or her? Should the child have special academic consideration because of his/her personal situation?

3. How might a teacher or counselor talk to a teenage student who is undergoing personal gender issues—for example, an intersex person whose personal gender assignment does not match the assignment determined by his or her parents? Another example might be a student who is completely male or female physiologically, but feels like a person of the opposite gender and is considering sex change after reaching adulthood. How might a teacher or counselor approach the parents in this situation?

4. What should teachers and administrators do if an intersex or homosexual student who wants privacy is "outed" by his or her peers? What if a student's peers are uncomfortable with a student who is outspoken about his or her status as an intersexual, a homosexual, or any other sexual or gender status that might make other students or parents uncomfortable?

Activity 5: Let's Call the Whole Thing Off

Based on video and online text content

60 minutes

Setup

Gender development affects the entire person, not just development of external genitals and internal reproductive organs. In this activity, read the article on gender and intellectual ability. Then, in teams of four that are composed of two men and two women, try tests that measure skills at which men and women generally show differences and discuss the questions provided.

Materials

- One copy each of the Article Excerpt, Tests, and Discussion Questions per person (master copy provided)
- A stopwatch, watch with second hand, or timer for each team of four
- A tennis ball or other small ball for each team of four
- A wastebasket or other target for each team of four

Scientific American Article Excerpt

Women weep over *An Affair to Remember*. Men compulsively channel-surf. Women can't drive. Men can't express emotions. Do these stereotypes reflect real biological differences between the sexes?

As we saw from the Biology of Sex and Gender video, the development of sexual organs depends on the presence or absence of a Y chromosome. In the absence of a Y, ovaries develop. If a Y chromosome is present—or more specifically, the SRY gene that normally resides on Y—testes develop. The subsequent production of testosterone leads to male physiology. The assumption has been that sex hormones are also responsible for behavioral differences between males and females, with supporting evidence coming from animal studies. Newborn female guinea pigs that are exposed to testosterone become males in both appearance and behavior. Male rodents that are castrated as newborns will grow up to exhibit reduced male mating behavior and increased female mating behavior.

However, if sex hormones alone are responsible for differences in male and female behavior, then we cannot explain cases like David Reimer. As shown in the video, David's male sex organs were removed soon after birth, after an accident during circumcision. He was raised as a girl and underwent hormone therapy; yet, at 14, he voluntarily changed his gender assignment, stating that he had always felt like a boy. These cases are rare, but anecdotal evidence like this suggests that a model in which gender identity is determined solely by physiology or levels of sex hormones is too simple.

Recent experiments by Eric Vilain from UCLA suggest that differences in male and female brain development may begin even before significant amounts of sex hormones are produced. Using DNA microarrays (see the Genomics unit), Dr. Vilain discovered that 51 of the 21,000 genes that were active in early mouse embryos were expressed differently in males and females—at a stage in which gonads had not yet developed. Although not all of the genes and their functions have been identified yet, these data suggest that differences in male and female brains may be determined very early. This leaves us a long way from a biological explanation of why male mice in a maze refuse to ask directions and the females just look for landmarks. Nonetheless, studies in human cognition suggest that the general intellectual patterns of males and females might really differ.

In laboratory tests of problem solving, men are, on average, better at spatial tasks like visualizing the rotation of an object; women are better at word recall and matching. Of course, the variation within a group of men or a group of women may be quite large, with a great deal of overlap between the abilities of the groups. However, when taken together, many of the differences reflect our stereotypes about male and female abilities. Generally, men navigate a labyrinth with fewer errors than women, while women are better at remembering the location of an object. Is that why Dad usually drives, but Mom knows where the car keys are? In any case, as investigations in gender determination move into early embryonic development, the debate continues over male and female stereotypes and roles. Contribute your own analysis by doing the following activities and discussions.

Sources:
Kimura, D. 2002. Sex differences in the brain. *Scientific American* , May 13. http://www.sciam.com/article.cfm?articleID=00018E9D-879D-1D06-8E49809EC588EEDF.

Dennis, C. 2004. The most important sexual organ. *Nature* 427:390.

Tests

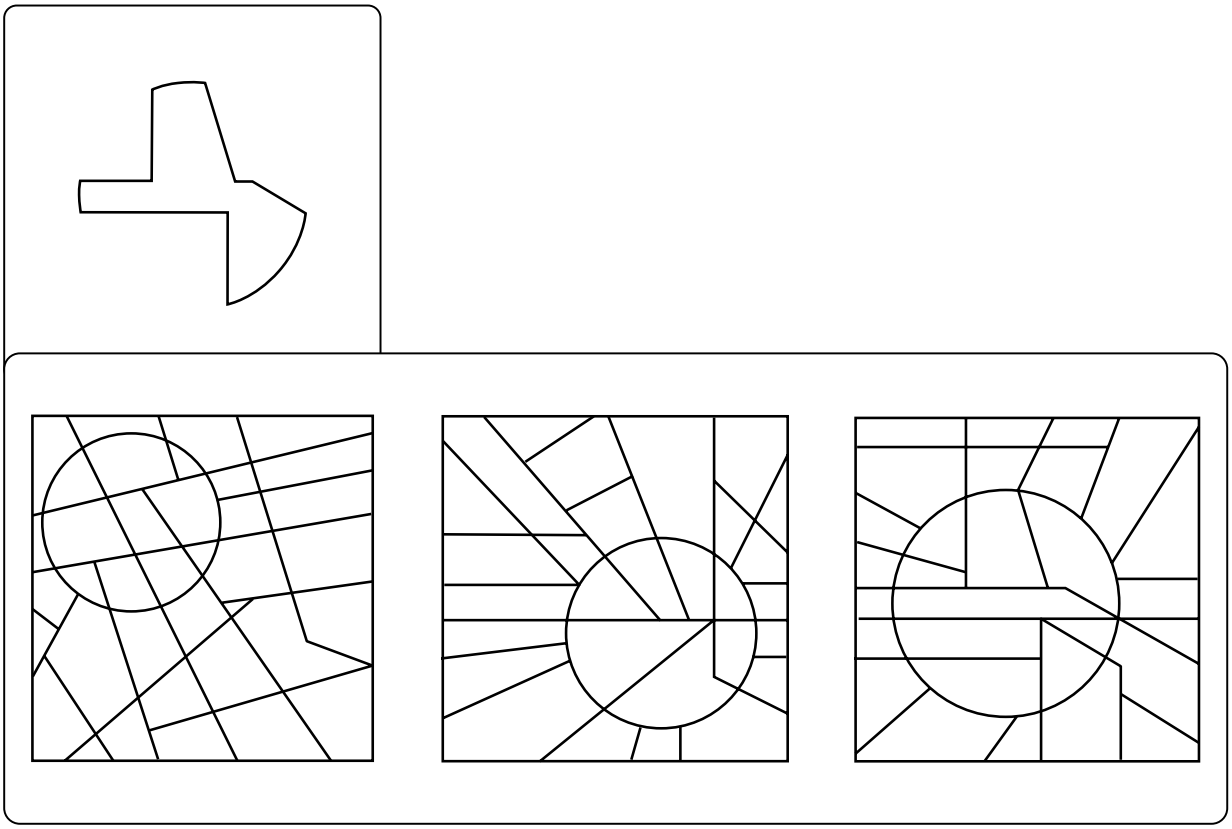
Take only one page (one test) at a time.

Test 1: Time each other to see how long it takes you to match the first picture in the top row with its identical copy in the bottom row.

Tests, cont'd.

Take only one page (one test) at a time.

Test 2: Time each other to see how long it takes to place the shape below into its matching shape in one of the complex line drawings.



Tests, cont'd.

Take only one page (one test) at a time.

Test 3: Give everyone 15 seconds to look at this list of unrelated words. Take away the words and have everyone write down as many as they can remember on a blank piece of paper.

dog

shadow

hamburger

cloud

flower

eyelash

opening

paper

water

light

fork

bank

lemon

fish

safety pin

key

comb

bird

paper clip

game

camera

scissors

gloves

complaint

Tests, cont'd.

Take only one page (one test) at a time.

Test 4: Set up a target, like a wastebasket or piece of paper on the wall. Take turns throwing a ball at the target and keep track of whom in your group is the most accurate.

Source: http://exn.ca/brain/tests/

Discussion Questions

1. Women are generally better performers on tests like Test 1, which measures "perceptual speed." Men are generally better performers on tests like Test 2, which measures "disembedding ability." Men are generally better at target-directed motor skills like throwing balls and other projectiles. Women are generally better at recall when read a story or list of unrelated words. Do the results of your group agree?

2. What kind of skill or ability do the tests measure? Why might women and men generally differ in their ability on these tests?

3. Do you think the tests you've just done are accurate measures of an innate skill? Or do they measure a learned skill or one that would improve with practice? Go back through the characteristics described in the article and see if you can think of tests that would measure these skills or abilities.

4. In the absence of a specific condition, like aberrant hormone levels, how would you explain exceptions—such as women with exceptional spatial abilities and men with exceptional word recall?

5. If the male-female differences in intellectual skill are genuine, what evolutionary reasons can you think of that might explain why women are generally better at remembering landmarks, recalling words, and performing tasks that require manual dexterity? What selective pressures might account for men generally being better at navigating mazes, detecting hidden geometric shapes, and throwing or catching projectiles?

Activity 6: Y?

Based on video content

15 minutes

Setup

The sequence of the Y chromosome has been determined, and this smallest human chromosome contains more genes than we had previously expected. Take a few moments to consider the implications of this discovery by discussing the provided questions.

Materials

- Optional: Paper Chromosomes (master copy provided in Activity 3)
- One copy of the Discussion Questions per person (master copy provided)
- Tips and Suggested Answers

Discussion Questions

See Tips and Suggested Answers for more information and answers.

1. At one point, the Y chromosome was thought to have a dozen genes or fewer. Now we know that it has 78—meaning that men have 78 genes that women do not have. David Page, one of the researchers who sequenced the Y chromosome, was interviewed for National Public Radio on June 19, 2003. In the interview, he said that while we say that all humans are 99.9 percent identical in DNA sequence, this statement is true only half the time—when comparing two males or two females. If we take into account the 78 genes on the Y chromosome that males have and females do not, males and females are only 98.5 percent alike in DNA sequence. A male chimpanzee and a male human are also 98.5 percent alike in DNA sequence. This leads Page to tell the interviewer "…you are about as similar to your wife as you are to a male chimp."

   Do you believe this statement is true? Or, are there other factors that make male and female humans more alike than humans and chimps? In any case, what does this information about the Y chromosome tell us about the differences between sexes?

2. (If you did Activity 3, review the information relevant to this question. If not, skip to the next question.) One of the functions of crossing-over (recombination) in meiosis is to protect against the deleterious effects of mutations. The reshuffling of allele combinations during meiosis means that mutant alleles of several different genes might, by random crossing-over, all end up on one chromosome. This chromosome carrying several lethal alleles would be lost by segregation into a gamete that would be inviable.

   However, crossing-over requires homologous chromosomes—that is, two chromosomes with the same genes. Except in rare cases of males with two Y chromosomes, the Y chromosome never has a homolog in meiosis with which to cross-over. What are the implications of this for genes on Y? How does the Y pair with X in meiosis if they are not homologous? Does knowing that the Y chromosome contains large repeated sections give you any clues about how it compensates for the inability to shuffle out mutant alleles?

3. The XY sex chromosome system means that men have genes that women do not. It also means that women, with two X chromosomes, have twice as many copies of the X chromosome genes as men. These include genes that encode carbohydrate metabolism enzymes, blood clotting factors, and color vision receptors.
   a. Humans are quite sensitive to having too many or too few copies of genes. Think of the consequences of trisomy 21 (Down syndrome). What mechanism balances the difference in X chromosome gene copy number and how does it work?

   b. What other systems are possible for balancing X chromosome gene copy number? (For example, *Drosophila* also have an XY chromosome sex determination system but they use a different mechanism than humans.)

Additional Information and Answers

1. One caveat to the genetic "differences between the sexes" is that the differences between male and female humans is in discrete genes. The differences between humans and chimps is over the entire genome, at every gene, at gene regulatory regions and in large changes in chromosome structure.
2. X and Y share enough homology at the ends that they can pair in meiosis in an XY male, and undergo limited crossing-over at these terminal regions. However, the bulk of the Y chromosome cannot undergo crossing-over, and is destined to accumulate mutations. The article notes that the Y chromosome has large, repeated regions, and suggests that these regions represent extra material that is available for repairing mutations.
3. a. In mammals, gene dosage of X chromosome genes is regulated by X-inactivation. During early development, both X chromosomes express a gene called *Xist* into Xist RNA. This RNA binds the X chromosome. Slight differences in the amount of Xist RNA cause one X to be condensed into an inactive Barr body; the other expresses its genes. In effect, female mammals have one functional X, just like males. Regulation is more complex than that, because having only one X chromosome, as in Turner syndrome, is not the same as having one inactivated and one expressed X.
   b. In other organisms with two different sex chromosomes, like *Drosophila*, dosage compensation can occur by either increasing the expression of X-linked genes in males, or decreasing expression in females.

Activity 7: You Be the Judge

Based on video content

15 minutes

Setup

The video for this unit included a bit of the history of gender testing in the Olympics, and covered some of the issues in human gender determination. Now that you've had a chance to apply and reflect on this information, discuss the following questions in pairs or in a group.

Materials

- One copy of the Discussion Questions per person (master copy provided)

Discussion Questions

1. According to *The Journal of the American Medical Association*, at the 1992 Winter Olympics in Albertville, France, 8 of 3387 (1 per 423) women were found to have the Y-linked gene *SRY*. Seven of the eight had complete or partial androgen insensitivity syndrome, and the eighth probably had a defect in an enzyme in a testosterone biosynthesis pathway.

   In your opinion, which, if any, of these people should be allowed to compete in women's events?

2. Do you think it would be fair for a true male who could "pass" as a female—and perhaps had the internal sense that he was more female than male—to compete in women's events in golf? swimming? soccer? basketball? boxing?

3. If you don't think this would be fair, should all athletes be tested for gender? How?

4. In your opinion, which is more important in determining gender: sex chromosome composition? appearance of external genitals? internal anatomy? self-identification? levels of sex-determining hormones?

5. In general, do you think biological or psychological criteria are more important in determining gender?

6. In biological terms, what do you think determines the critical features of maleness and femaleness in humans? What genes might be involved, and what might they encode?

Sources:
Simpson, J. et al. 2000. *JAMA* 284:1568–69.
Simpson, J.L. 1986. *JAMA* 256(14):1938.

Notes