

Now what we're going to do is watch a video that connects two of this morning's themes: meiosis and sex determination. The question is by what mechanism does an embryo come to carry a Y-chromosome or a second X. The answer is found in meiosis in the Father. So in this video of human male meiosis I want you to look for 2 things. Guess what they are? Gene swapping, the swapping parts of paired chromosomes, and dividing by two; halving the number of chromosomes per cell. So you'll remember that human cells have 23 pairs of chromosomes, but to illustrate the principles we're just going to show six pairs here, six pairs of chromosomes. And we're going to look in detail at two pairs, we're going to look at the x-y pair here, and a pair of autosomes. And you see that we have it arranged, so that mom's chromosomes... Right so you got half your chromosomes from mom and half from dad, we have it arranged so that Mom's chromosomes are on the left, in red, and the chromosomes you got from Dad are in blue, on the right. And what's the first thing that happens in meiosis? The very first step is, you actually don't divide by two, you multiply by two. You double all the chromosomes, double all the genes. So at the first step in meiosis you go to a $4n$, to a $4n$ stage. That's where we're beginning, let's roll the video. Ok so we're now going to blow up and focus on this pair of autosomes on the left, and you see there that recombination can occur at any point along the length of this autosomal pair. Let's see what happens when recombination occurs at a particular point. There's the swapping, we've just swapped a bunch of genes, the same can happen on the other arm of that pair of autosomes. Now we're going to turn over to the sex chromosomes, that's where the SRY gene is located on the Y. And it turns out the X and the Y can recombine only, they normally recombine only within their ends. Let's see how the swap occurs in detail. So we've just swapped some parts, some stuff from Mom and Dad down at the other ends like so. So at this point how many copies of each autosomal gene does this cell have? Four, we still have four. We have two copies of the X and two of the Y, and four of every autosome. Ok and what we're going to see, what are we going to do now? We've got to go from four copies down to one per cell. So we're actually going to have two rounds of division. And you're going to see the X up here is going to go to two cells on the top, the Y is going to go to two cells on the bottom, we're going to get four sperm out of this one cell. Let's roll the video. Ok here comes the first division, the cell on the top has two copies of every gene, cell on the bottom too. Now comes the second division. Remember we've got the X's in the two cells on the top the Y's on the two cells at the bottom. And these are going to go on to mature into sperm. So we will have X bearing sperm on the top, and Y bearing sperm on the bottom. And now these sperm have to go in search of eggs, let's roll the video. Now they're fired up, in the experiment on the top the X bearing sperm in purple are going to win, down below the Y bearing sperm, we end up with an XX fertilized egg and an XY fertilized egg, and as we said, during the first six weeks of human development are anatomically, histologically indistinguishable in male and female. We progress up to the 7-week stage right here and it's only at this point that the SRY gene fires and leads to the birth of a male or female. Ok so how do XX males carrying SRY arise? How do XY females deleted for SRY arise? I want you to remember that XX males are carrying a terminal portion of the Y chromosome, the XY females are missing a terminal portion of the Y chromosome. We're going to see how that happens in a rerun of part of the video we just watched. Let's run that video now. Ok so here again we've got the six chromosomes that are representing our 23 pairs. Now we're going to look just at the XY pair. And we're going to watch an aberrant recombination or gene swapping. So there again is

the SRY gene on the Y chromosome recombination would normally be restricted out at the very ends of the X and the Y, but occasionally an aberrantly placed recombination event - Look! That one is too far down, and look what's happening, the SRY gene is being passed over to an X-chromosome, and look here's a Y chromosome that has lost SRY as a result of this misplaced swapping event. So we end up with an X-chromosome that is SRY+ and a Y-chromosome that is SRY- That is exactly how XX males and XY females in humans are generated.