

## Mitosis and Meiosis Prompt

1. What is the cell cycle? What are the stages of the cell cycle and why is the cell cycle important?

2. What is the point of mitosis? Explain the process of mitosis and the end product.

3. What is the point of meiosis? Explain the process of meiosis and the end product. Be sure to explain why chromosome reduction is important in terms of reproduction.

4. What is the significance of crossing over during meiosis?

# Meiosis

## State Standard GENETICS

2. Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept, students know;

- a. meiosis is an early step in sexual reproduction in which the pairs of chromosomes separate and are segregated randomly during cell division to produce gametes containing only one chromosome of each type.
- b. that only certain cells in a multicellular organism undergo meiosis.

# Vocabulary: Meiosis/Reproduction

Name \_\_\_\_\_

Word Part	Meaning	Vocabulary Word
meio	diminish	meiosis
-zyg/-zygo	joined	zygote
gamet	Wife/husband	gamete
Feto	Fetus/fetal	fetoscope
Ultra	Beyond the ordinary	ultrasound
Som-	Body	Somatic
Com	With, together	Recombination
		Sperm
		egg

Format

Word	Part of speech	Word parts
meiosis		
zygote		
gamete		
Fetoscope		

Ultrasound	
somatic	
recombination	
sperm	
egg	

Video

## Meiosis

### Differences between Mitosis and Meiosis

- Mitosis is used for \_\_\_\_\_ when the cell is \_\_\_\_\_ or is \_\_\_\_\_ to get all the nutrients in that it needs and \_\_\_\_\_
- The cell duplicates \_\_\_\_\_ and any deviations can cause the cell to \_\_\_\_\_
- Mitosis the cells are \_\_\_\_\_ meaning that they have same traits on them. Meiosis the cells \_\_\_\_\_ which have genes for the \_\_\_\_\_
- Mitosis occurs in \_\_\_\_\_ and Meiosis is in \_\_\_\_\_

### Meiosis

- This process is used for \_\_\_\_\_
- This means that the information from \_\_\_\_\_
- The offspring will be a \_\_\_\_\_
- The cells are \_\_\_\_\_ chromosome meaning that they have only \_\_\_\_\_
- When \_\_\_\_\_ join the original \_\_\_\_\_
- Chromosome number is \_\_\_\_\_ and if the individual has \_\_\_\_\_ significant \_\_\_\_\_ will occur.

### Phases of Meiosis

#### Interphase: the cell

- In females mammals like humans this is \_\_\_\_\_

#### Prophase I:

- Chromosomes \_\_\_\_\_
- Each pair of homologous chromosomes \_\_\_\_\_ and \_\_\_\_\_ (4 part structure)
- \_\_\_\_\_ non-sister homologous chromosome \_\_\_\_\_: this is called \_\_\_\_\_

- \_\_\_\_\_ results in new \_\_\_\_\_ (possible traits) on the \_\_\_\_\_ chromosomes.

**Metaphase I:** Spindle fibers pull the \_\_\_\_\_

**Anaphase I:** Homologous chromosome each with its chromatids \_\_\_\_\_

- This way each new cell \_\_\_\_\_ from each pair.

**Telophase I:** Each cell winds up with \_\_\_\_\_ ( \_\_\_\_\_ ) of the old cell but it is still too much!!

### Meiosis II

- Prophase II: Spindle fibers \_\_\_\_\_ of the one chromosome from each pair.
- Metaphase II: chromosomes \_\_\_\_\_
- Anaphase II: The \_\_\_\_\_ and the sister chromatids \_\_\_\_\_
- Telophase II: \_\_\_\_\_

### RESULTS OF MEIOSIS

The most important is \_\_\_\_\_ Either by \_\_\_\_\_ or \_\_\_\_\_ the new individuals will be \_\_\_\_\_

### MISTAKES

The \_\_\_\_\_ is when \_\_\_\_\_ chromosomes do not separate and \_\_\_\_\_. This is called \_\_\_\_\_ of one chromosome will result in \_\_\_\_\_ Either having \_\_\_\_\_

When there are \_\_\_\_\_ the cell is said to be \_\_\_\_\_ - this can result in \_\_\_\_\_

## Lesson 10: Sex cells and Meiosis

### Key Words

- Gametes - sex cells
- Egg - female sex cells
- Sperm - male sex cell
- Haploid number - number of chromosomes found in a gamete
- Diploid number - number of chromosomes found in a somatic cell
- Somatic cell - body cell / non-gametic cell
- Meiosis - type of cell division that produces gametes
- Polar Bodies - smaller gametes resulting from meiosis in eggs

**Key Idea:** During sexual reproduction, two sex cells join. Each sex cell contains half the number of chromosomes found in the body cells of the parents. The process in which the number of chromosomes in a cell is reduced by half is called meiosis.

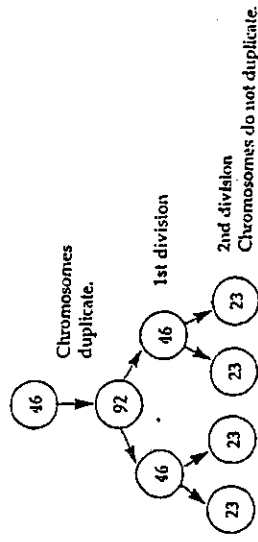
Our bodies consist of millions of cells. However, all humans begin life as only one cell. The one cell is formed by the joining of two sex cells: one from the mother and one from the father. After 36 hours, the cell divides to form two cells. Five days after the first cell formed, it had divided enough to produce 120 cells.

**Sex cells.** All organisms that reproduces sexually (plants as well as most animal forms) produce sex cells called **gametes** (GAM-eets). Female gametes are called egg cells. Male gametes are called **sperm**. Each gamete contains half the number of chromosomes as a somatic cell of the organism. The number of chromosomes in a gamete is described as the **haploid number** (HAP-loid NUM-buhr).

A single **somatic** (body) cell from a particular organism contains a certain number of chromosomes. For example, human somatic cells contain 46 chromosomes each. The somatic cell of a dog contains 78 chromosomes and an earthworm has 36 chromosomes. The number of chromosomes in a single body cell is called the **diploid number** (DIP-loid NUM-buhr). Since the body cell of a spider plant contains 24 chromosomes, its diploid number is 24.

**Meiosis and Chromosomes.** The kind of cell division by which diploid cells produce haploid gametes is called meiosis (my-OH-sihs). Meiosis occurs in two stages. The first stage resembles mitosis. In this stage, the chromosomes in the parent cell duplicate, or make exact copies of each other. When this cell divides, each of the two resulting daughter cells contains the same number of chromosomes as the original parent cell.

Fig. 10-1 Meiosis in a human cell



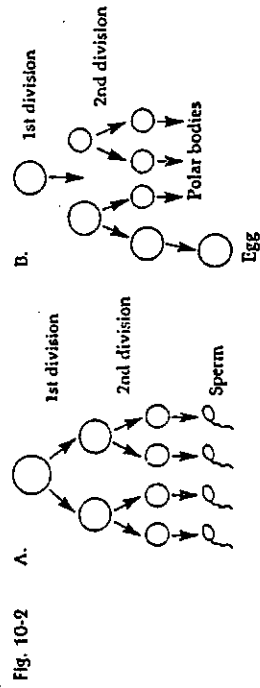
In the second stage of meiosis, each daughter cell divides a second time. Unlike mitosis, this second cell division does not begin with duplication the chromosomes. Thus, when the daughter cells divide, each of the four cells produced has half as many chromosomes as the original parent cell Fig. 10.1 shows meiosis in a human cell.

By dividing twice, the original diploid cell produces haploid gametes. When two such gametes join during sexual reproduction, the form a single cell that again has a diploid number.

**Sperm and Eggs.** During meiosis, a single cell divides twice to form four daughter cells. In males, meiosis produces four sperm cells of almost equal size. In females, meiosis produces four cells of varying size. One cell receives most of the cytoplasm, making it much larger than the other three cells. The large cell becomes the female gamete, or egg cell. The three smaller cells are called **polar bodies**. **Polar bodies** are not involved in sexual reproduction but ser a support function.

Occasionally, something goes wrong during meiosis. The parent cell does not separate evenly, causing a daughter cell to have an abnormal number of chromosomes. If this gametes joins with a normal gamete during sexual reproduction, the new cell that forms the diploid number. An organism that develops from this cell will have a chromosomal disorder like Turner's syndrome or Down's syndrome.

Fig. 10-2 shows the differences that occur in the formation of sperm and eggs.



Checking your Understanding.

1. How do gametes differ from somatic cells?

Write a sentence explaining the connection between each group of words.

2. gametes, egg cell, sperm cell

3. diploid, haploid, meiosis

Complete the following passage using words from the list below

Divisions      diploid number      egg      four      gamete  
Haploid number      meiosis      polar bodies      two      somatic

The (4) \_\_\_\_\_ of an organism is twice its (5) \_\_\_\_\_ . A (6) \_\_\_\_\_ contains half the number of chromosomes found in the (7) \_\_\_\_\_ cells of an organism. Gametes are formed through (8) \_\_\_\_\_. In this process, a parent cell undergoes two (9) \_\_\_\_\_. The first stage of meiosis produces (10) \_\_\_\_\_ daughter cells. In males, the second stage of meiosis results in (11) \_\_\_\_\_ sperm cells. In females, one (12) \_\_\_\_\_ and three (13) \_\_\_\_\_ are formed.

Name \_\_\_\_\_

Complete exercises 14-18 by adding the correct number to the sentences. Use the fruit fly as an example.

- 14. If the body cell of a fruit fly contains 8 chromosomes, its diploid number is \_\_\_\_\_.
- 15. The haploid number of a fruit fly is \_\_\_\_\_.
- 16. When a somatic doubles its chromosome number to begin meiosis it contains \_\_\_\_\_ chromosomes.
- 17. Cells produce by the first division of meiosis contain \_\_\_\_\_ chromosomes.
- 18. Cells produced by the second division of meiosis contain \_\_\_\_\_ chromosomes.

19. EXPLAIN the difference between a gametic and somatic cell.

20. How is the number of sperm cells and egg cells produced by meiosis different?

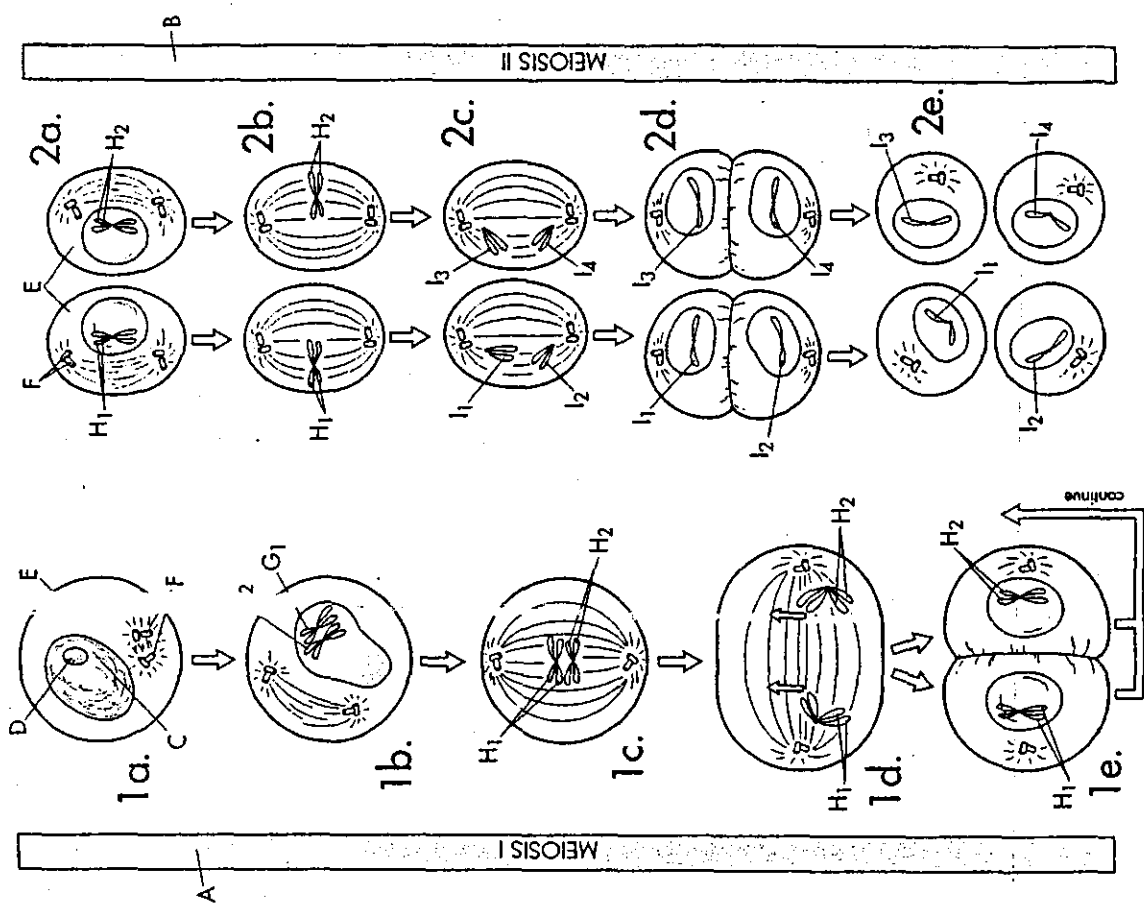
21. Explain THREE WAYS mitosis and meiosis are different.

- A.
- B.
- C.

Name \_\_\_\_\_

**Questions**

1. How many cells are produced at the end of mitosis? \_\_\_\_\_ How many at the end of meiosis? \_\_\_\_\_
2. What does diploid mean. \_\_\_\_\_
3. What does haploid mean? \_\_\_\_\_
4. Where does meiosis take place? \_\_\_\_\_
5. What are the gametes called? \_\_\_\_\_
6. What is it called when they fuse together? \_\_\_\_\_ Is it diploid or haploid? \_\_\_\_\_
7. How many cell divisions are in meiosis? \_\_\_\_\_
8. In what cell division does crossing over occur? \_\_\_\_\_
9. How many cells are produced after meiosis 2? \_\_\_\_\_
10. Are the cells diploid or haploid? \_\_\_\_\_



- Chromosome 1
- Chromosome 2
- Chromosome 3
- Chromosome 4

## Summary Sentences

Paragraph 1	
Paragraph 2	
Paragraph 3	
Paragraph 4	
Paragraph 5	
Paragraph 6	
Paragraph 7	
Paragraph 8	
Overall Summary	

move to the left pole of the cell while sister chromatids 2 move to the right. In telophase, sister chromatids 1 are contained in the left daughter cell, and sister chromatids 2 are in the right daughter cell. This marks the end of meiosis.

6. At the end of meiosis I, the chromosome pair has separated and a chromosome that consists of two sister chromatids has moved to each daughter cell. The sister chromatids are held together at the centromere. Each of the two daughter cells will now enter meiosis II. The two daughter cells now enter meiosis II, shown at the top of the second column. View 2a shows prophase. Again, we see the centriole (F) and the cytoplasm (E), which should be colored in a pale color. Sister chromatids 1 (H1) are in the left cell, and sister chromatids 2 (H2) are in the right cell. In view 2b, the sister chromatids line up along the equator of each cell. Then the kinetochores separate the sister chromatids.

7. Now, in view 2c, anaphase is in process, and the sister chromatids are considered chromosomes. In the left cell, chromosome 1 (I1) moves to one side of the cell, while chromosome 2 (I2) moves to the other. Chromosome 3 (I3) and chromosome 4 (I4) separate in the second cell. As telophase commences, in view 2d, the chromosomes are situated at the poles, and the nuclei are taking shape once again. Cell division (cytokinesis) begins.

8. In the final view, 2e, we see the four cells that result from cytokinesis. Each cell is haploid, meaning that it contains a single chromosome from the original chromosome pair. Recall that we began with two chromosomes. Now in the final view, each cell has one chromosome from that original pair. In the human male, these cells will undergo further development to become sperm cells, and in the human female, one of these cells will become an egg cell.

9. Meiosis is linked to sexual reproduction in plants and animals because haploid cells join to form a fertilized diploid cell. In animals, the haploid cells join to form a fertilized diploid cell. In animals, the haploid stage is very brief, but in simple plants, the haploid stage predominates over the diploid stage.

### Meiosis

1. The process of mitosis occurs in cells that are reproducing during growth and wound healing, and replacement of dead cells. The two cells that arise from mitosis are genetically identical to their parent cell. Certain cells undergo another form of cell division known as meiosis. In this process, a single parent cell produces four cells, each of which has half the number of parental chromosomes. The parent has two sets of chromosomes and is said to be diploid (2N), while the cells that result from meiosis each have a single set of chromosomes and are said to be haploid (1N).

2. Meiosis takes place in the reproductive organs and results in cells that are used during reproduction. These cells, which are sperm and egg cells, are called gametes. At fertilization, the fusion of two haploid gametes forms a single cell, called the zygote, which is diploid. In this plate we trace the two main phases of meiosis. Many of these processes are similar to those of mitosis. We will follow a single pair of chromosomes through the process of meiosis and will note how they are distributed to four cells.

3. The process of meiosis involves two rounds of cell division, known as meiosis I (A) and meiosis II (B). The bars that indicate these two rounds should be colored. The first round results in daughter cells that have reduced numbers of chromatids. In the second round, these chromatids are distributed to the gametes. Each round of meiosis contains a prophase, metaphase, anaphase, and telophase, as is the case of mitosis.

4. We will begin with meiosis I. Here we see a parent cell with a distinctive nucleus (C) and nucleolus (D). The cytoplasm (E) should be colored in a pale color. The centriole (F) functions in meiosis as it does in mitosis. The phase designated Ia represents prophase. Prophase continues in view 1b. Here a single pair of chromosomes is considered (remember that humans have twenty-three pairs of chromosomes per cell). We see homologous chromosome 1 (G1) and chromosome 2 (G2) have come together, and crossing over may take place.

5. View 1c represents metaphase. The homologous chromosomes line up along the equator of the cell, and we see that each consists of sister chromatids. Chromosome 1 has sister chromatids 1 (H1), and chromosome 2 consists of sister chromatids 2 (H2). Anaphase is shown in view 1d. Sister chromatids 1

who runs the MicroSort clinic. "It'll depend on what society wants."

The American Society for Reproductive Medicine frowns on using gender selection for "family balancing" and the American Medical Association's president is even blunter: "We have to draw a line in the sand." She thunders. But if we've learned anything about technology advances in this century, it is that there's no stopping them, no matter their ethical or moral implications.

The battle against gender selection can only be won person to person. On the argument that surprise does more to improve life than does certainty, I persuaded my wife to join me in gender ignorance throughout her pregnancy, back in simpler time. In a world sodden with information and reality, can people really not stand even a delicious instant of mystery?

**XX or XY They will be done:** By Marc Fisher: Washington Post

Washington: They enter the soulless brown midrise in silence, strangers in a Fairfax, VA., office park, eager to remain anonymous ready to play God. Smiling professionals usher them quietly past rows of cubicles - this could be a mortgage company, or a telemarketer - and into a seminar room.

Forty people in their 30s and 40s. Would be parents who want to subvert a basic rule that has stood throughout the history of living things: When it comes to boy vs girl, you take what comes. Not anymore. This is the headquarters of the Genetics - IVF Institute, where barriers of reproductive technology are routinely smashed. The institute's latest product is Microsort, a machine that sifts through sperm and separates the X's from the Y's, allowing customers to choose whether to have a boy or a girl. Price: \$2,500 per menstrual cycle (on average, it takes four cycles to achieve pregnancy).

The process isn't quite foolproof - in trials thus far, 93% of the couples who wanted a girl have gotten their wish and 73 percent of the couples seeking a boy got one - but it's convincingly better than God's even odds (50/50) which work this way. The egg always carries an X chromosome. The sperm, however, can be X or Y with about 50% chance of being either. If the sperm X joins the egg X, a girl is formed. If the sperm Y joins the egg X, a male is formed.

Nature's way isn't faring too well in reproduction these days: science is gaining in many ways. In the past decade the proportion of women who pick their delivery date by having their doctors induce labor has doubled to 18 percent. Geneticists can screen fetuses for dozens of diseases, allowing parents to decide whether to let nature take its course or to halt the process and try again. The infertility industry had become a robust profit center in medicine, extending women's childbearing years almost unimaginably.

But gender selection is a big step. It's the closest we've come so far to designer kids.

Edward Fugger, the biologist who developed MicroSort, based on the U.S. Department of Agriculture research on animals, shows nifty slides that look like constellations at an extremely hip planetarium - foggy splashes of light, green for Y chromosomes and pink for X chromosomes. Fugger's sorting machine is based on a simple fact: X-chromosomes have more DNA. Measure the DNA in each sperm cell, and voila, sex selection.

Throughout this introductory evening, the questions focus not only on the science, but on the ethics and security of the process. Several people fixate on the danger of sample-swapping. One man even wants to watch his ejaculate as it moves throughout the lab.

But the evening really gets interesting when a woman asks: "What about a couple that has no children, and wants one of a particular sex?" Fugger stiffens. "At this time, that's not a criterion for this trial" he says.

Genetics-IVF limits participation in the MicroSort trials to married couples who already have at least one child. And the institute says only two kinds of couples are permitted to use the process: people at risk for one of 350 - odd diseases linked to the X chromosome, and families who want to balance their gender mix. People such as the couples sitting in front of me, who have three boys and wouldn't mind seeing what a girl is like.

This is not what some in the audience want to hear. They want one child, and they want it in their favorite flavor. Which leads one woman to exclaim. "I can't believe you're not regulated. You can just decide yourselves what you want to do?"

"It's our decision not to do first children, that's correct," Fugger says.

"What will happen in five or 10 years we don't know." Adds Keith Blauer, the physician

No question, it was odd having strangers know which sex our child would be - various prenatal tests revealed the truth to doctor, nurses, office managers - but loved the suspense. Through a ludicrous combination of nonvideance old ladies walking up to my wife on the street to pronounce her bulge male, slips of the tongue by nurses who had seen our test results and then referred to the fetus as "he" - we were convinced our first child was going to be a boy.

I can think of no moment in my life more thrilling than life emerging - a shock of black hair, an open mouth with stunning lips, a long torso, and then my wife gasping in shock: "A girl! It's a girl!"

## Summarize the major points

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.

# Chapter 10: Mendel and Meiosis

## 10.2 Meiosis

pgs.269-279

### Genes, Chromosomes, and Numbers

Main Idea

Supporting Detail			

Diploid:

Haploid:

Homologous Chromosomes:

Sperm:

Egg:

Zygote:

Sexual Reproduction

Word Origin and meaning: Meiosis

Name \_\_\_\_\_

### The Phases of Meiosis

Main Idea

Supporting Detail			

Crossing Over:

Dominant:

Recessive:

Law of Segregation:

### Meiosis Provides for Genetic Variation

Main Idea

Supporting Detail			

Genetic Recombination:

Name \_\_\_\_\_

Word Origin: pro-

meta-

ana-

telo-

Meiosis Video

### Mistakes in Meiosis

Main Idea

Supporting Detail			

Nondisjunction:

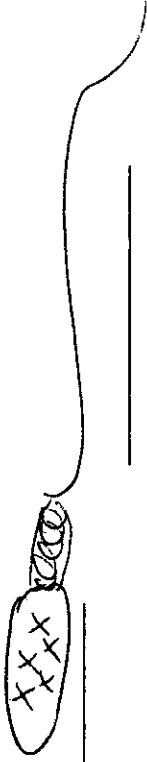
### Section Assessment 1-5

1. How are the cells at the end of meiosis different from the cells at the beginning of meiosis? Use the terms chromosome number, haploid, and diploid in your answer.
2. What is the role of meiosis in maintaining a constant number of chromosomes in a species?
3. Why are there so many varied phenotypes within a species such as humans?
4. If the diploid number of a plant is 10, how many chromosomes would you expect to find its triploid offspring?
5. How do the events of meiosis explain Mendel's law of independent assortment?

## Reproduction & Development

### Male system

- A male produces millions of sperm \_\_\_\_\_
- The parent cell is \_\_\_\_\_ and each sperm is \_\_\_\_\_
- A sperm matures for \_\_\_\_\_
- Most of the cell organelles are \_\_\_\_\_. The \_\_\_\_\_ stays near the head to power the tail.
- The cap has \_\_\_\_\_ to help penetrate the egg.
- 250 - 450 million sperm are \_\_\_\_\_
- New research indicates that there are \_\_\_\_\_ different types of sperm, only \_\_\_\_\_ can fertilize the egg.



- Sperm are produced in the \_\_\_\_\_ located in the \_\_\_\_\_: loose hanging sac \_\_\_\_\_ the penis.
- The sperm can not be formed in \_\_\_\_\_ conditions but needs 4° below body temperature.
- After the sperm are formed they are \_\_\_\_\_ in the \_\_\_\_\_ and later in the \_\_\_\_\_
- It is usually the Vas Deferens that is cut during a \_\_\_\_\_ thus preventing the sperm from \_\_\_\_\_
- Any sperm that is not \_\_\_\_\_ by the body.
- If sperm is removed from these areas it is \_\_\_\_\_ and can not fertilize an egg.
- When the sperm is \_\_\_\_\_ from the body, \_\_\_\_\_ of the Vas Deferens pushes the \_\_\_\_\_ into the \_\_\_\_\_.
- Smooth muscle contracts around the bladder's opening to \_\_\_\_\_

- \_\_\_\_\_ are added to the sperm are called the \_\_\_\_\_
- Seminal vesicles produce a fluid that \_\_\_\_\_ the sperm.
- The bulbourethral (\_\_\_\_\_) gland and the prostate gland \_\_\_\_\_ an \_\_\_\_\_ that acts as a \_\_\_\_\_
- The prostate gland often \_\_\_\_\_ after a man is past 45 years old and can \_\_\_\_\_ the urethra.
- **Important Hormones**
- \_\_\_\_\_ is produced by the testes.
- In Vitro (in the womb) testosterone develops the \_\_\_\_\_
- At puberty the \_\_\_\_\_ and develops \_\_\_\_\_ characteristics such as a beard, low voice and muscles.
- \_\_\_\_\_ the production of sperm.
- The hypothalamus in the brain produces important \_\_\_\_\_
- Female Reproductive System** Female gametes are called \_\_\_\_\_ (ovum). The \_\_\_\_\_
- They are \_\_\_\_\_ the uterus.
- The eggs go through the \_\_\_\_\_ of meiosis while the female is still and embryo.
- Later they 'ripen' by going through \_\_\_\_\_
- Eggs are \_\_\_\_\_ and travel into the \_\_\_\_\_ which carry the egg to the \_\_\_\_\_
- The uterus is a \_\_\_\_\_ which can expand during pregnancy.
- The \_\_\_\_\_ is a strong ring of muscle at the bottom of the uterus.
- The \_\_\_\_\_ is a muscular tube that accepts the sperm. It is highly \_\_\_\_\_ that keep harmful bacteria out of the uterus.
- **The Ovarian Cycle**
- The egg grows inside the \_\_\_\_\_ located in the ovary.
- Generally one egg is released \_\_\_\_\_ during \_\_\_\_\_

J11

- If the egg is \_\_\_\_\_, it is removed.
  - The eggs mature once \_\_\_\_\_ starts.
  - e. The mature egg grows to \_\_\_\_\_ times the size of the \_\_\_\_\_.
- Fetal Development**
- During ejaculation 250 - 450 sperm are released.
  - Most \_\_\_\_\_ make it out of the \_\_\_\_\_ through the cervix.
  - \_\_\_\_\_ the sperm leave the \_\_\_\_\_ and half will go up the wrong fallopian tube.
  - Many sperm reach the egg and start to '\_\_\_\_\_,' the outer covering.
  - \_\_\_\_\_ enters and a \_\_\_\_\_ immediately occurs which prevents any other sperm to enter.

**After fertilization**

- The \_\_\_\_\_ egg moves through the Fallopian tube into the uterus and \_\_\_\_\_ in the lining.
- If the \_\_\_\_\_ in the Fallopian tube and is \_\_\_\_\_ by the doctor, the woman can die.
- After \_\_\_\_\_ the egg \_\_\_\_\_ into two cells by \_\_\_\_\_ and is called an embryo.
- By the time the embryo reaches the uterus it is made up of a \_\_\_\_\_ cells and is \_\_\_\_\_.
- The \_\_\_\_\_ and starts to use up the stored materials in the egg.
- The \_\_\_\_\_ and it starts to transmit \_\_\_\_\_ to the fetus through the \_\_\_\_\_ cord.
- The \_\_\_\_\_ of the mother \_\_\_\_\_ flow into the fetus; their blood is separated by the vessel walls and \_\_\_\_\_ into the fetus's vessels and \_\_\_\_\_ into the mother's vessels.

- Many \_\_\_\_\_ can pass from the mother to the fetus and create \_\_\_\_\_ for generations to come.
- 0-4 weeks \_\_\_\_\_ heart forms and begins to beat.
- 5-8 weeks \_\_\_\_\_ legs, feet toes. Females form ovaries, males form testes, \_\_\_\_\_ system forms.
- 9-12 weeks \_\_\_\_\_ penis is distinct, chin and facial structures, head dominant and body lengthens.
- 13-16 weeks \_\_\_\_\_ mother feels activity.
- 17-20 weeks Limbs full size, eyelashes and eyebrows form.
- 21-30 weeks Substantial \_\_\_\_\_, may survive if born
- 30-40 weeks Fingernails and toenails are present.

**Labor**

- .After about 9 months (\_\_\_\_\_); fetus is ready to be born.
- The head moves to above the \_\_\_\_\_ can begin several weeks before birth.
- Strong contractions begin and are called labor. This can last 5+ hours.
- The baby is pushed out past the cervix and down the vagina.
- The \_\_\_\_\_

**Video:**

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# Crossing Over

## Crossing Over

1. The process of crossing over may cause permanent changes in the genetic makeup of chromosomes. Crossing over occurs during prophase 1 of meiosis and takes place between paired **HOMOLOGOUS** chromosomes.

2. We will follow a homologous pair of chromosomes and see what happens when crossing over occurs and when it fails to occur. We will point out that only two types of gametes are possible without crossing over, but **FOUR** different types of gametes are possible when crossing over does occur, making it an essential source of variability.

3. In the first process, variability is not introduced into a species because crossing over does not take place. We begin by looking at the pair of chromosomes in diagram 1, at the top. This is a homologous pair, meaning that DNA has duplicated just before the start of meiosis. The result of this DNA duplication was a pair of sister chromatids for each homologous chromosome. The first homologous chromosome now consists of sister chromatids A (A) and Sister chromatids B (B).

4. As we see in the first diagram. Sister chromatids A had gene 1 (C) and gene 2 (D). Both sister chromosomes have these genes because they are essentially copies of one another. Sister chromatids B have gene 3 (E) and gene 4 (F). Genes 1 and 3 may be alleles of the same gene, while genes 2 and 4 may also be alleles of a gene, but we are not concerned with dominance or recessiveness here. In diagram 2, the sister chromatids appear as they did in diagram 1. Diagram 2 represents the point in prophase 1 at which the homologous chromosomes come together and sister chromatids form a tetrad. The chromatids stand side by side, crossing over has not occurred yet.

5. In diagram 3 the chromatids have separated during anaphase 1 and you can see four chromosomes (G). Now, in telophase, we note that the first chromosome contains genes 1 and 2 and the third and fourth chromosomes have genes 3 and 4. As you can see there are two

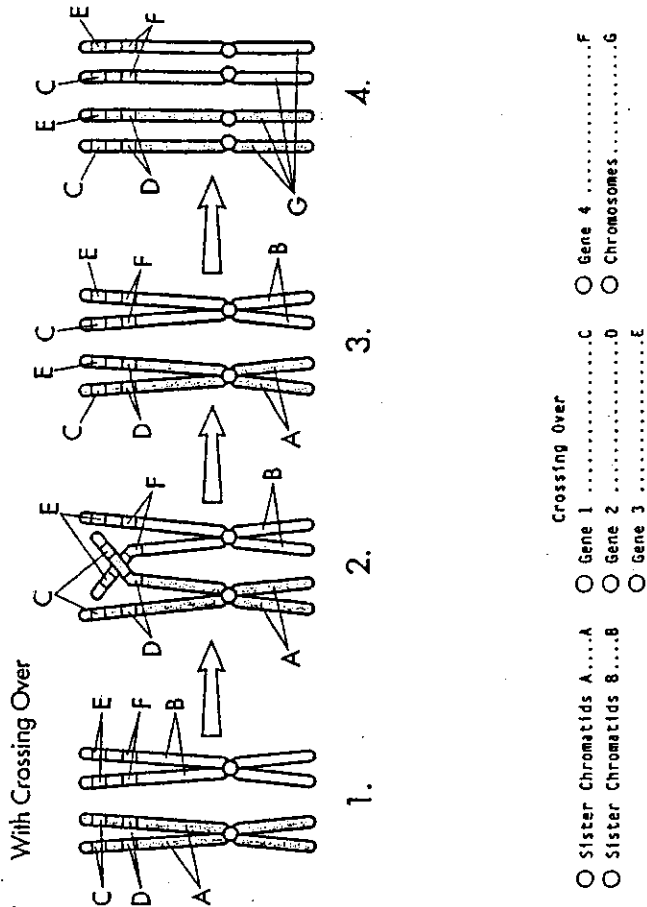
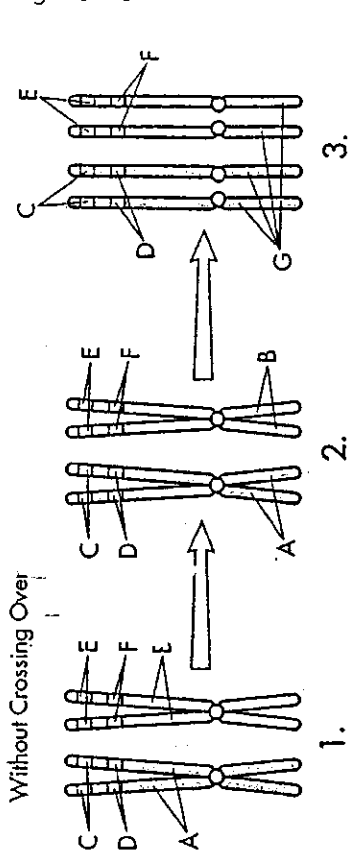
types of chromosomes which means that only two types of sex cells are possible.

6. We now consider the second part of the diagram, where crossing over takes place. Once again, we focus on sister chromatids A (A) and B (B). This diagram is similar to the one above it but, as we move to diagram 2 we see a difference. Here sister chromatids exist in a tetrad formation, but crossing over occurs. Notice that the second and third chromatids cross one another, and exchange of genes is taking place.

7. As we move to diagram 3, we see the effects of crossing over. Chromatids 2 in sister chromatids A now has a gene 3 (E) and its original gene 2 (D). In sister chromatids (B), the third chromatid now has gene 1 (C) PLUS its original gene 4 (F). Thus, the second and third chromatids are different because of crossing over. Only the first and fourth chromosomes remain unchanged.

8. Now we move to the fourth diagram, in which the chromatids have separated during anaphase. Now they exist as chromosomes. When we examine the genetic composition of the chromosomes, we see a dramatic difference because of the crossing over. Chromosome 1 has gene 1 and 2 (D) as expected, but chromosome 2 has genes 3 (E) and gene 4 (F). They are now four different chromosomes, and when these chromosomes are distributed to sperm or egg cells, four different cells can result. Without crossing over only two different cells could result.

9. Crossing over is tremendously significant in the evolutionary process. For example, a chromosome might acquire an advantageous allele that joins an already advantageous allele. At fertilization, the offspring might receive this allelic pair and have a genetic advantage. Thus, the offspring would be favored by natural selection to reach reproductive age and pass the advantageous alleles to its offspring. This is one of the ways in which crossing over contributes to evolution.



Crossing Over

○ Sister Chromatids A....A    ○ Gene 1 .....C    ○ Gene 4 .....F  
 ○ Sister Chromatids B....B    ○ Gene 2 .....D    ○ Chromosomes .....G  
 ○ Gene 3 .....E

## Crossing Over

Name \_\_\_\_\_

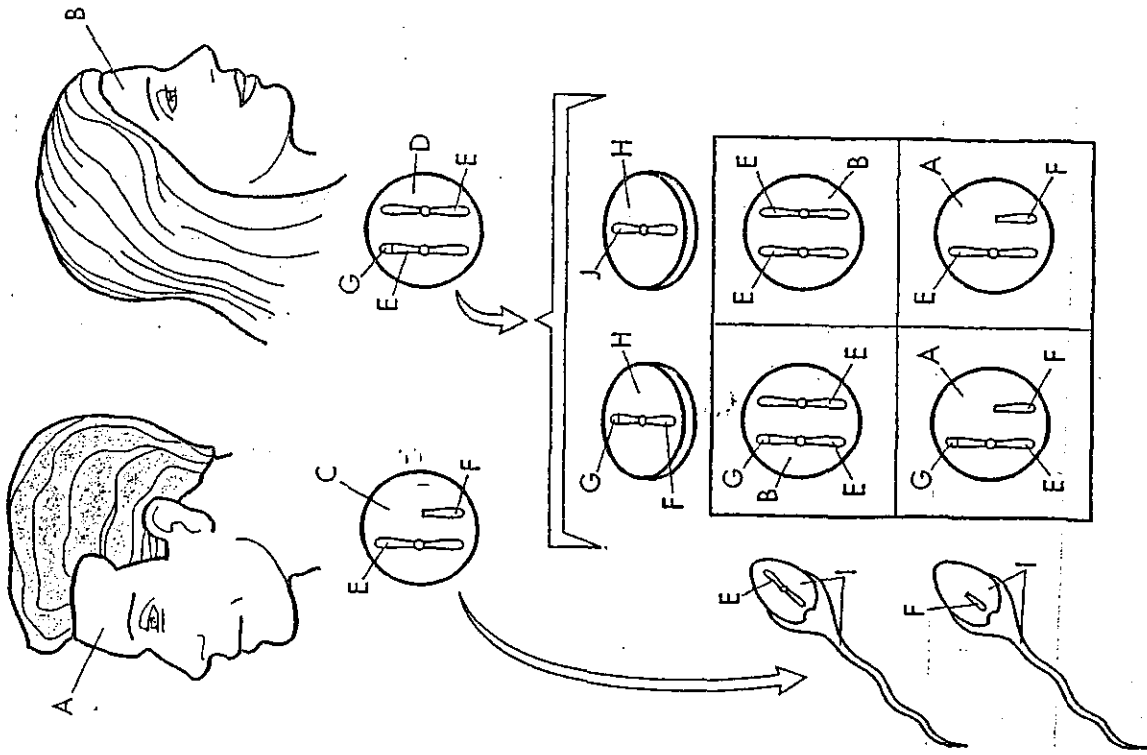
### Summary Sentences

Paragraph 1	
Paragraph 2	
Paragraph 3	
Paragraph 4	
Paragraph 5	
Paragraph 6	
Paragraph 7	
Paragraph 8	
Paragraph 9	
Overall Summary	

### Questions

1. When does crossing over occur?
2. If crossing over does not occur, how many different types of chromosomes are possible?
3. What actually occurs when crossing over takes place (HINT - look at picture #2 in the lower diagram).
4. How many different types of chromosomes develop when crossing over occurs?
5. What is the advantage?

Name \_\_\_\_\_



**Questions**

1. Where is a sex-linked gene found? \_\_\_\_\_
2. How many X chromosomes do females have? \_\_\_\_\_  
How many do males have? \_\_\_\_\_
3. Is colorblindness dominant or recessive?
4. Explain how a woman can be a carrier of colorblindness but not be colorblind.
5. Does the mother or father pass along the colorblindness trait? EXPLAIN how you know this.
6. What must occur for a woman to be colorblind?
7. What must the genotype be for EACH of the following
  - a. vision homozygous female \_\_\_\_\_
  - b. colorblind male \_\_\_\_\_
  - c. normal vision male \_\_\_\_\_
  - d. normal vision carrier (heterozygous) female \_\_\_\_\_

### Sex-Linked Traits

In humans certain genes are found on one sex chromosome and not the other: these genes are called sex-linked genes. For instance the human X chromosome contains the genes for color vision as well as for blood clotting, and these genes do not exist on the Y chromosome. Females have two X chromosomes so that any allele that's missing or defective on one X chromosome may exist on the other. Males, by contrast, have to express whatever allele appears on their X chromosome, because they don't have another X chromosome allele that can "mask" it. In this plate, we will show how sex-linked traits work.

Looking over the plate, you will notice that we show a cross between a male and female. Both the male and female have normal vision, but the female is a carrier for the trait of colorblindness.

Color blindness is a much studied sex linked trait that occurs in humans. The allele for normal color vision is dominant, and the allele for colorblindness is recessive. The allele for color blindness renders individuals unable to distinguish shades of red or green-these colors appear gray. About 8% of American males are colorblind, but only 0.6% of females can't see colors.

In this plate, we cross a male (A) with a female (B). Notice that we show a male cell (C) and a female cell (D), and that the male cell contains an X chromosome (E) and a smaller Y chromosome (F).

Examining the female cell (D), we see that one of the X chromosomes carries the colorblindness allele (G), which is recessive. This part of the allele should be colored darkly to distinguish it. Since the woman has an allele for normal vision on her other X chromosome, the normal allele will mask the defective one, and she will see red and green normally. The male has no colorblindness allele.

We have seen that the male does not have the color blindness trait, and that the woman is a carrier of the color blindness trait, although she

sees colors normally. We will now examine the offspring of this pair to see how the colorblindness trait expresses itself.

When the female in our study produces gametes (in meiosis) two types of cells (H) result. One of these egg cells has the colorblindness trait (G), while the other egg has the allele for normal vision (J).

When the male forms sperm cells (I), two different types are possible. During meiosis, the alleles separate, and one sperm cell ends up with the X chromosome (E), while the other has the Y chromosome (F).

We will now perform the cross. Take a look at the Punnett square; in the offspring in the upper left corner, one X chromosome comes from the female and one has been contributed by the male. The result is a female (B) that has one colorblind allele and one normal allele; she will have normal vision. Now look at the upper right portion of the Punnett square - this individual is also female, with two X chromosomes (E), neither of which has the color blindness trait. She has normal vision.

Next examine the bottom row of offspring. In the bottom left, we see a male (A) who has acquired an X chromosome from the mother and a Y chromosome from the father - he has acquired the colorblindness trait (G). Because there is neither another X chromosome with a normal allele that will mask the color blindness trait, nor an offsetting normal trait on the Y chromosome, this male will be colorblind. Finally, examine the individual in the lower right. This male (A) has acquired an X chromosome from the mother and a Y chromosome from the father. The X chromosome carries the normal vision trait, so this individual will be able to see red and green.

To summarize the results of this cross, we can say that the possible four results of this mating are a normal-vision carrier female, a normal-vision homozygous female, a colorblind male and a normal-vision male. Thus there are two chance in four that the offspring will be male, and if it is a male, there is a 50% chance that he will be colorblind.

## Summary Sentences

Paragraph 1
Paragraph 2
Paragraph 3
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Paragraph 5
Paragraph 6
Paragraph 7
Paragraph 8
Paragraph 9
Paragraph 10
Paragraph 11
Overall Summary

## Gender Determination / Karyotyping

### Gender Determination:

Humans have \_\_\_\_\_ of chromosome. The \_\_\_\_\_ is the one that determines \_\_\_\_\_.

There are \_\_\_\_\_: the larger of the two is in an \_\_\_\_\_ and the \_\_\_\_\_.

The ONLY chromosome that the \_\_\_\_\_ can give the child is an \_\_\_\_\_ and the \_\_\_\_\_ may give the child \_\_\_\_\_.

By getting an \_\_\_\_\_ and \_\_\_\_\_ the child is \_\_\_\_\_.

By getting an \_\_\_\_\_ the child is a \_\_\_\_\_.

It is the \_\_\_\_\_ that determines the \_\_\_\_\_ of the child. The \_\_\_\_\_ has a \_\_\_\_\_ on it called the \_\_\_\_\_ that carries the information for the developing fetus to release \_\_\_\_\_ into its blood stream. This makes the \_\_\_\_\_.

Without this \_\_\_\_\_ the fetus will stay \_\_\_\_\_.

There are some traits like \_\_\_\_\_ and \_\_\_\_\_ that are carried on the \_\_\_\_\_ and \_\_\_\_\_ considered \_\_\_\_\_.

These show up more commonly in \_\_\_\_\_.

### KARYOTYPING

\_\_\_\_\_ are identified and numbered by their \_\_\_\_\_ of their \_\_\_\_\_.

They are then put in order and scanned for \_\_\_\_\_.

This is a method used for identifying \_\_\_\_\_ - it can check for \_\_\_\_\_ parts or \_\_\_\_\_ entire \_\_\_\_\_.

Having additional parts or missing parts result in \_\_\_\_\_.

## 48 Hours: Fragile X

The following questions are answered throughout the video and are NOT just in the order listed here!!

1. What is Fragile X?
2. What are the traits or characteristics of someone with Fragile X?
3. Who is more severely affected, boys or girls and WHY?
4. Can men pass the trait on to their sons? Why or why not?
5. What are ways to check each person?
6. What can a pedigree show?
7. What is the cure?
8. Could all the children in a family be affected? EXPLAIN

Name \_\_\_\_\_  
**Sex determination and Sex Linkage**

Show ALL your work.

1. What is an autosome?
2. How many pairs of autosomes does a human cell have?
3. How many pairs of sex chromosomes does a human cell have?
4. What is the probability of a man and his wife having a baby girl?
5. Which parent determines the sex of the offspring?
6. Explain how the cells of a human might contain two X chromosomes and one Y chromosome.
7. What sex would the person be?
8. In fruit flies eye color is sex linked. The gene for red eyes is dominant to the gene for white eyes.
  - A. A white-eyed female fruit fly is crossed with a red-eyed male. What is/are the genotype/s of the F-1 (first generation) female?
  - B. What are the genotypes of the F-1 males?
  - C. What would be the phenotypes of all offspring?

9. In humans, the gene for normal color vision is dominant to the gene for red-green color blindness. The trait is sex-linked. A woman of normal vision whose father was colorblind marries a man of normal vision.

- A. What type of vision can be expected in their offspring?
  - B. Suppose the man's father was also colorblind. Would this affect the couple's children? Explain your answer.
10. Ability to see color is sex-linked; eye color is not sex linked. The gene for dark colored eyes is dominant to the gene for eyes that are light in color. Calculate the probable genotypic and phenotypic ratios of the children born to a blue-eyed woman who is heterozygous for color vision and a heterozygous brown-eyed man who is color blind.

J18

12.3 DNA: Complex Inheritance of Human Traits  
 pgs. 329-335

Name \_\_\_\_\_

Codominance in Humans

Section Assessment 1-5

Main Idea

Supporting Detail			

Sex-Linked Traits in Humans

Main Idea

Supporting Detail			

Polygenic Inheritance in Humans

Main Idea

Supporting Detail			

Word Origin: autosome

Changes in Chromosome Numbers

Main Idea

Supporting Detail			

Karyotype: A picture of the chromosomes

1. Why are sex-linked traits such as red-green color blindness and hemophilia more commonly found in males than in females? Explain your answer in terms of the X chromosome.
2. In addition to revealing chromosome abnormalities, what other information would a karyotype show?
3. What would the genotypes of parents have to be for them to have a color-blind daughter? Explain.
4. Describe a genetic trait in humans that is inherited as a codominance.  
  
Describe the phenotypes of the two homozygotes and that of the heterozygote. Why is this trait an example of codominance?
5. A man is accused of fathering two children, one with type O blood and another with type A blood. The mother of the children has type B blood. The man has type AB blood. Could he be the father of both children? Explain your answer.



# Karyotyping Scatter Sheet

Name \_\_\_\_\_

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22		23	

**Condition: description and treatment**

**Sex of child**

# Karyotyping Lab

## ANALYSIS QUESTIONS

1. How many chromosomes were present in the karyotype you completed?

2. What was the sex of the child who donated these chromosomes?

3. Did you find the fetal chromosomes to be (apparently) normal or abnormal?

4. If the karyotype has an abnormal number of chromosomes, use the chart "Human Birth Defects" to identify the condition. List the genetic characteristics of the condition.

5. Explain what a sex linked trait or disorder is. Give an example.

6. Why would it be important to determine a person's pedigree before having children?

7. Could brown eyed parents have 10 out of 10 children with blue eyes? Why or why not?

8. Could you change your genotype or phenotype