Unit 2

Why do some people get heart disease and not others, and what can we do to prevent it?
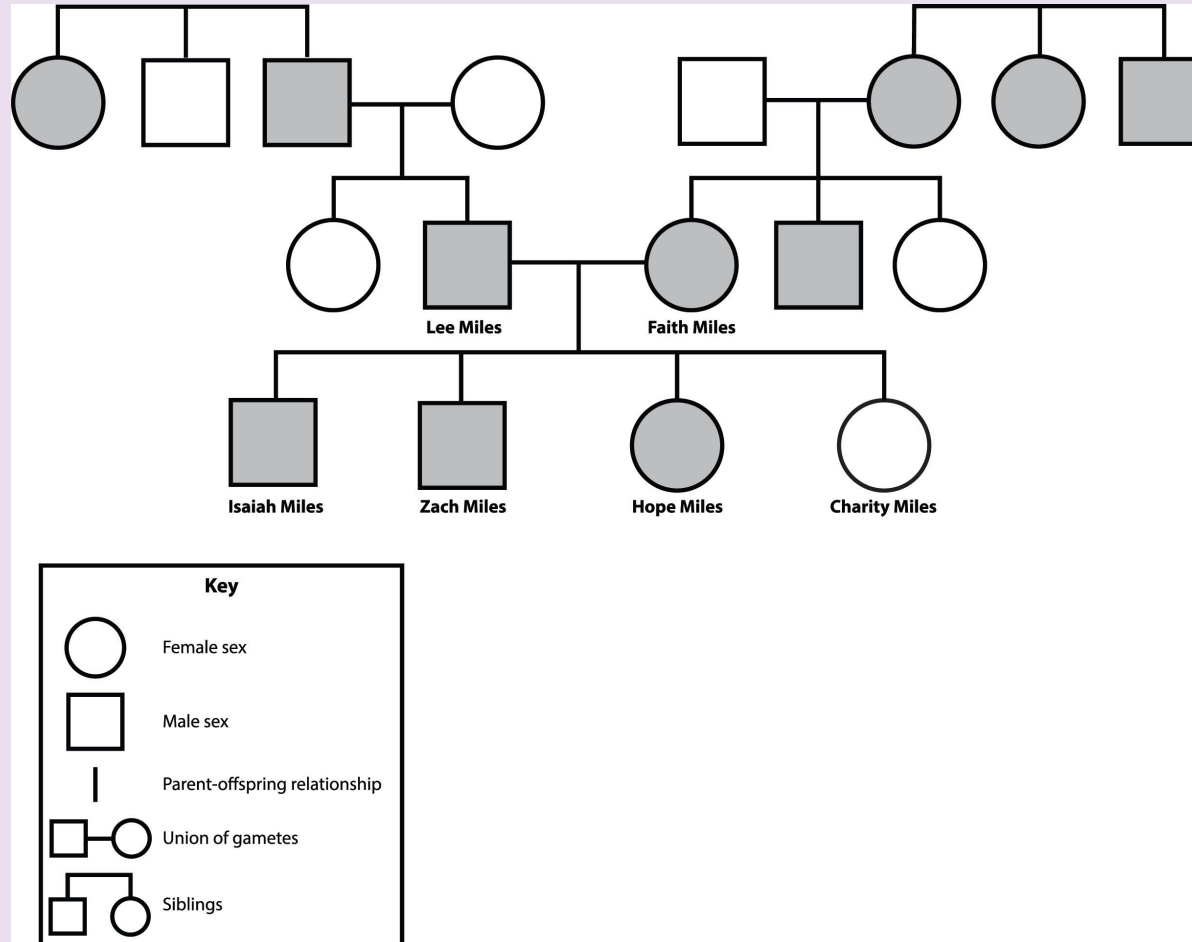
Lesson 8
Day 1

With your class

What were we still wondering about?

- Who gets heart disease and who doesn't?

- What differences do we see within families?

- If a family has a mutated allele of a gene that causes high LDL cholesterol levels, why aren't all members of the family the same?

- Is there a good way to organize all the information about families?
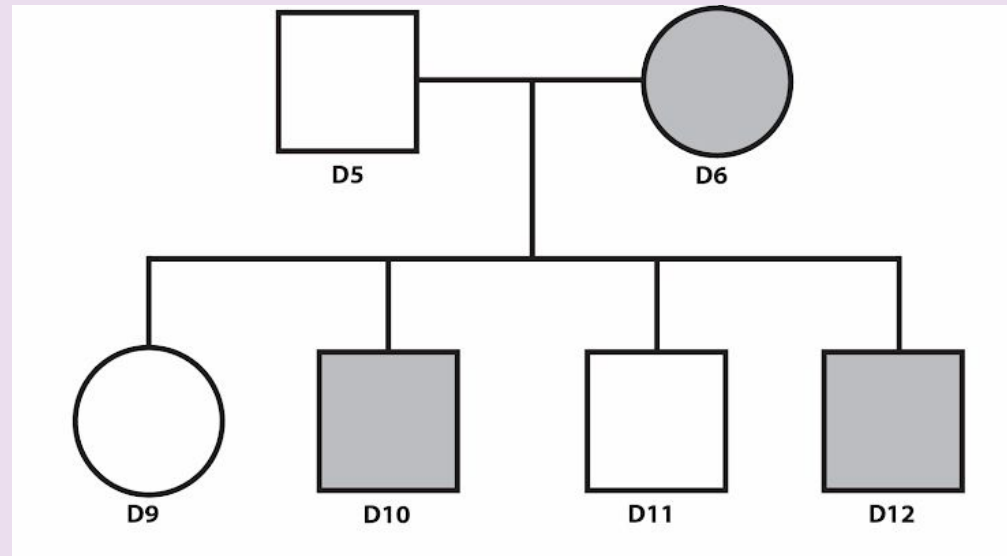
A

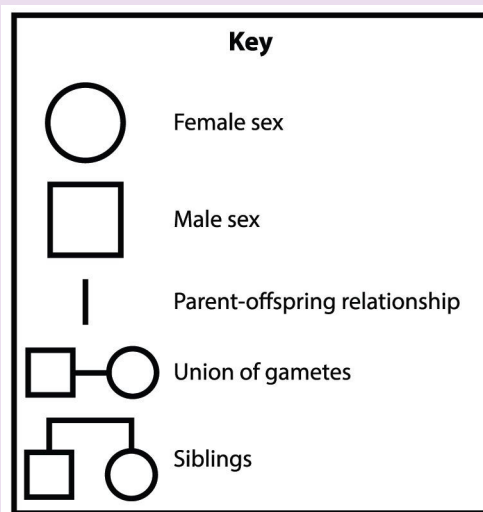# With your class

Pedigree of the Miles family

B

With your class

Reading a pedigree

C

👥 With your class

Student Sheet 2.8.A

Complete the pedigree and questions for your assigned family

On the Pedigree chart, all you need to do is add the LDL cholesterol level to each person's symbol

Example

Write in the cholesterol level for each named person on your pedigree chart

B3
B4

240 mg/dL

LDLR/LDLRdel1
PCSK9/PCSK9
APOB/APOB
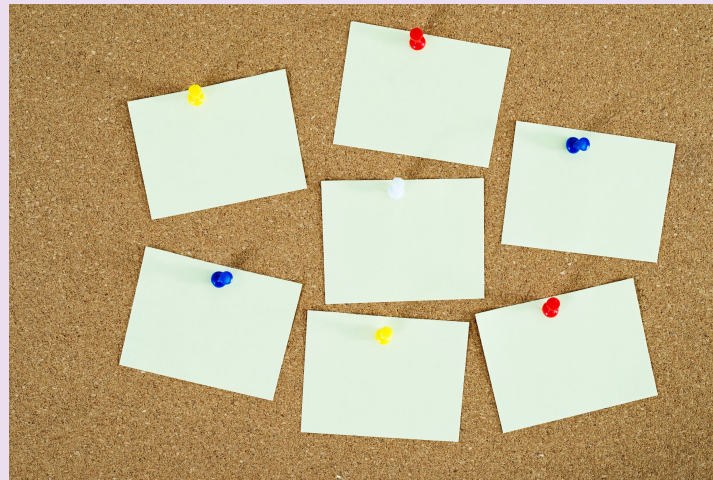
B9
Lee Miles

10:00

C

With your class

Let's share some of our observations from working in groups on the pedigrees.

- We might want to add some words to our Word Wall.

- What questions do you have?

© Shutterstock.com

D

Write this in your notebook

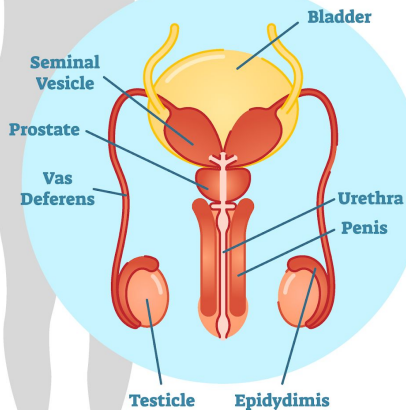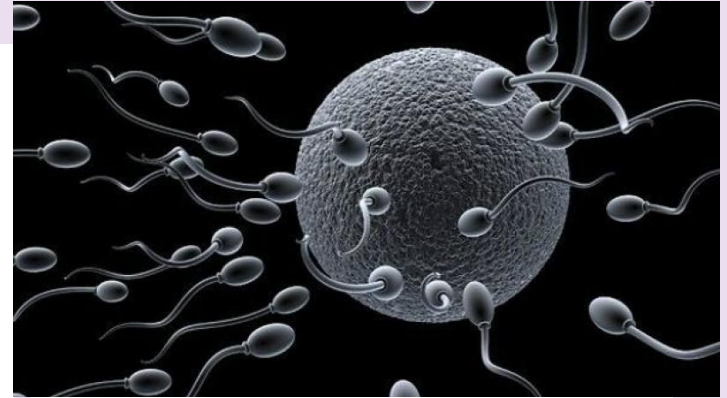**Lesson 8:** How can two siblings have very different genotypes and outcomes?

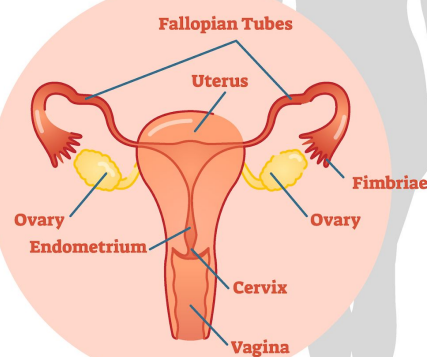**D**

BSCS SCIENCE LEARNING

Kendall Hunt

With your class

How do siblings inherit different allele combinations?

© Donna Ellen Coleman/Shutterstock.com

E

BSCS SCIENCE LEARNING

Kendall Hunt

👤 On your own: Sheet 2.8.B

Science Close Read Protocol

1. Before reading:
   a. Set a purpose.
   b. Preview the text for challenges and make a plan.
2. During reading:
   a. Read for understanding and annotate the text.
   b. Read the text *again* to highlight and annotate **key** ideas.
3. After reading:
   a. Record the key ideas that address your purpose.
   b. Jot down additional questions you have now.

Add these to your word wall

- **Gametes:** Reproductive cells, sperm or egg, that contain half the amount of DNA as other cells
- **Zygote:** A fertilized egg, which is the combination of two gametes (egg and sperm) that is the first cell that can become a human.

© Shutterstock.com

D

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Add these to your word wall

- **Meiosis:** Cell division that takes one cell and divides two times, resulting in 4 gametes (sex cells)
- **Independent Assortment:** Chromosomes randomly sort in to gametes leading to multiple possible chromosome combinations in any one gamete.
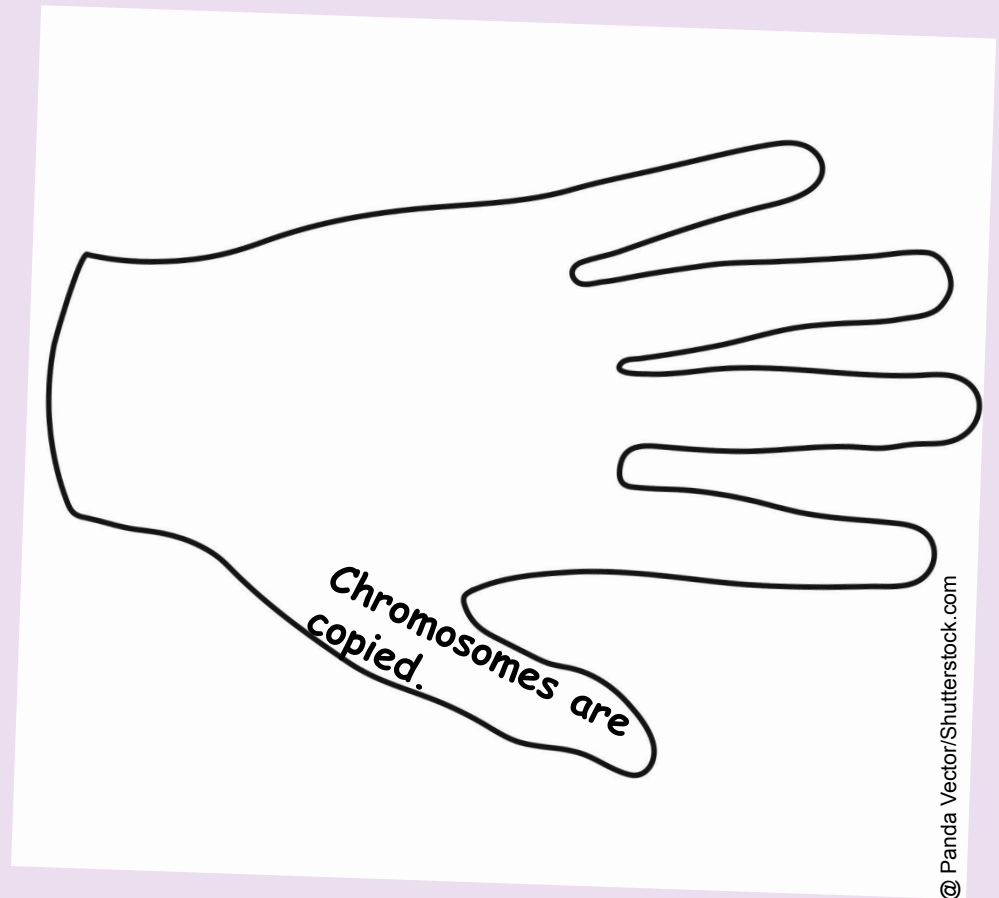
© Shutterstock.com

D

With your group

As a group, we will build a summary of meiosis by creating a "handy" reminder.

Trace your hand in your notebook. Starting with the thumb, write one thing on each finger that sums up what happens to make gametes.
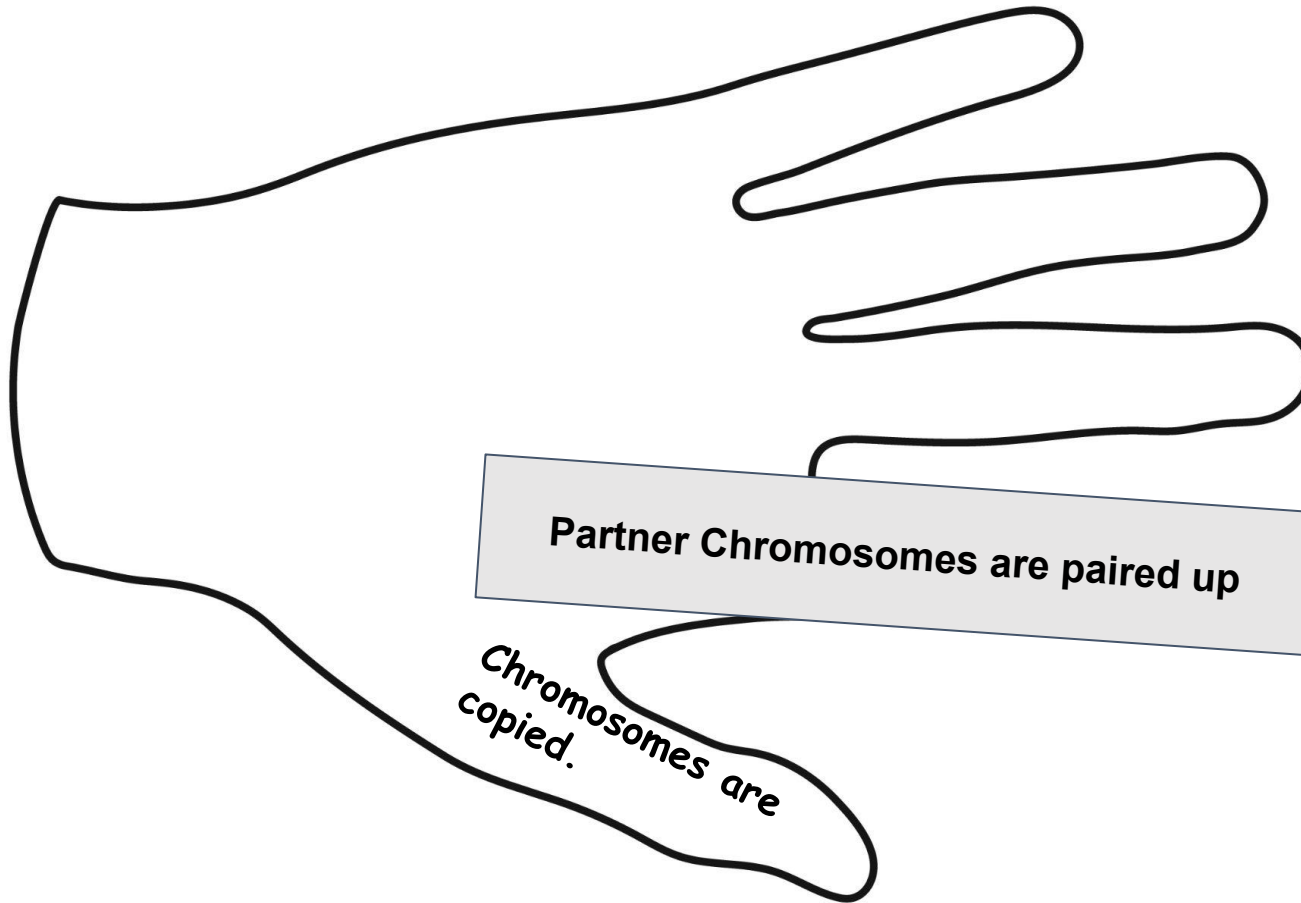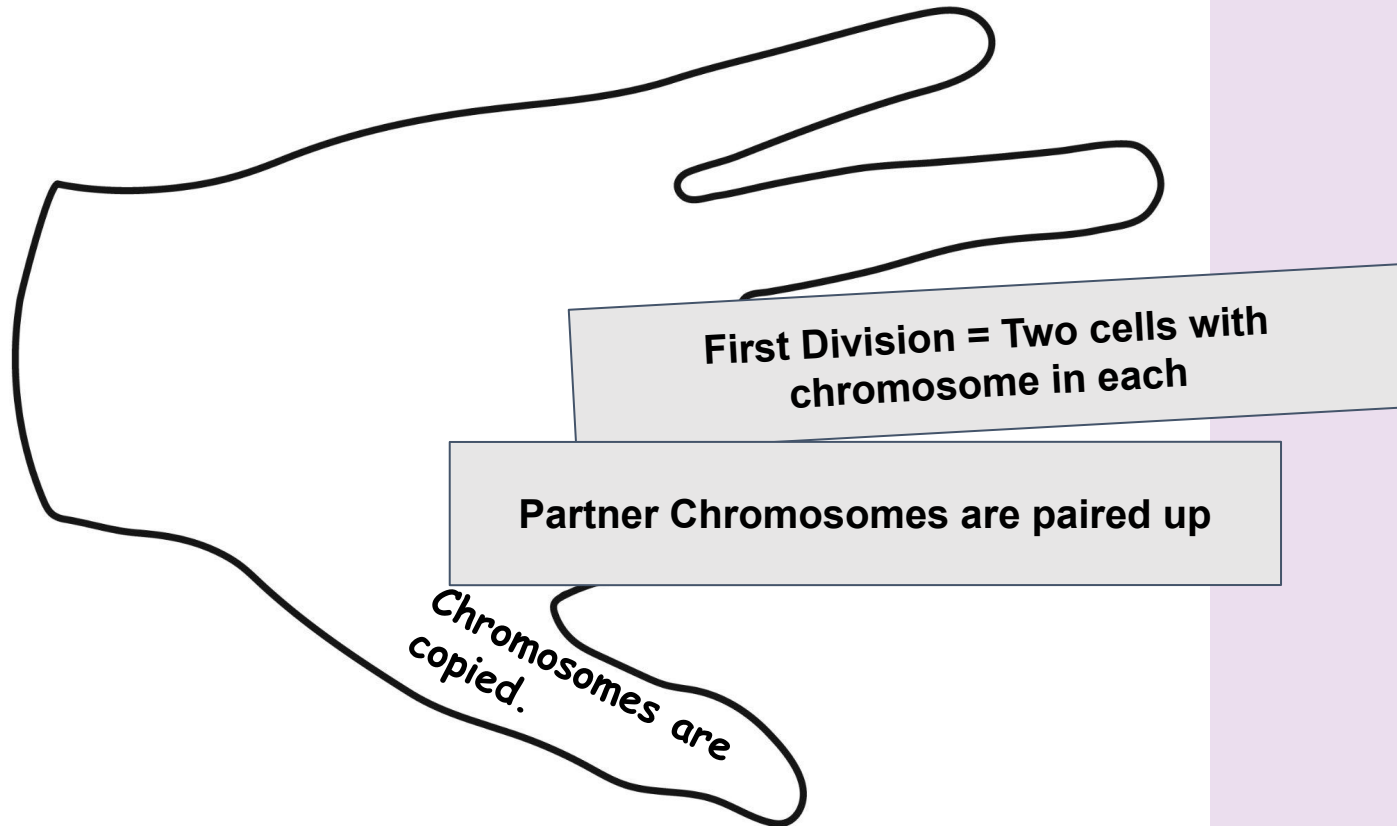
Keep it simple!

Copy the example.

Chromosomes are copied.

@ Panda Vector/Shutterstock.com

G

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With your group

Partner Chromosomes are paired up

Chromosomes are copied.

G

With your group

First Division = Two cells with chromosome in each

Partner Chromosomes are paired up

Chromosomes are copied.

@ Panda Vector/Shutterstock.com

G

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Kendall

With your group

New Cells divide and chromosomes do to

First Division = Two cells with chromosome in each

Partner Chromosomes are paired up

Chromosomes are copied.

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G

With your group

Four cells each with one Chromosome

New Cells divide and chromosomes do to

First Division = Two cells with chromosome in each

Partner Chromosomes are paired up

Chromosomes are copied.

G

With your class

These steps seem to be important

1. The chromosomes are copied (or duplicated).
2. The chromosomes that carry similar chromosomes pair up.
3. One division results in two cells, each with one chromosome.
4. Those two cells each divide and separate the two copies of each chromosome they carry into separate cells.
5. That allows **four** possible gametes with one chromosome each.

Can this help us explain what's happening with all the different siblings in our pedigrees?

H

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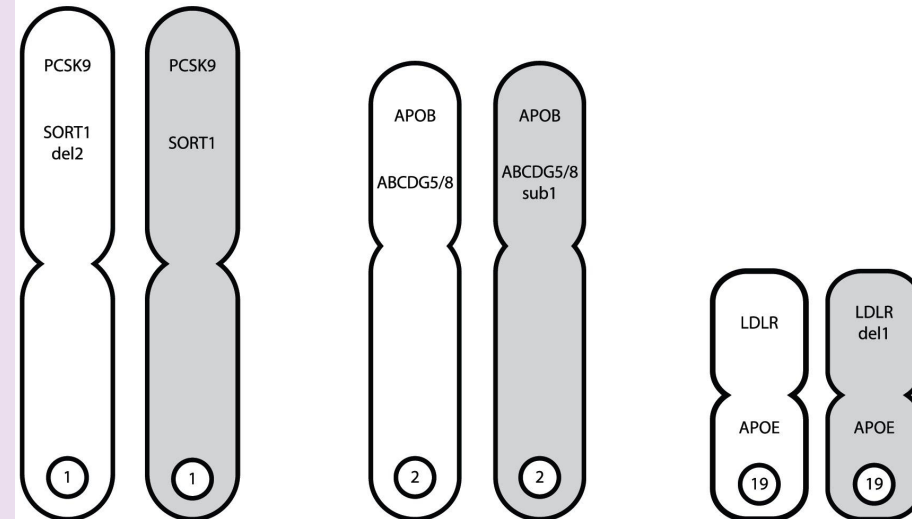Kendall Hunt

Complete Student Sheet 2.8.C
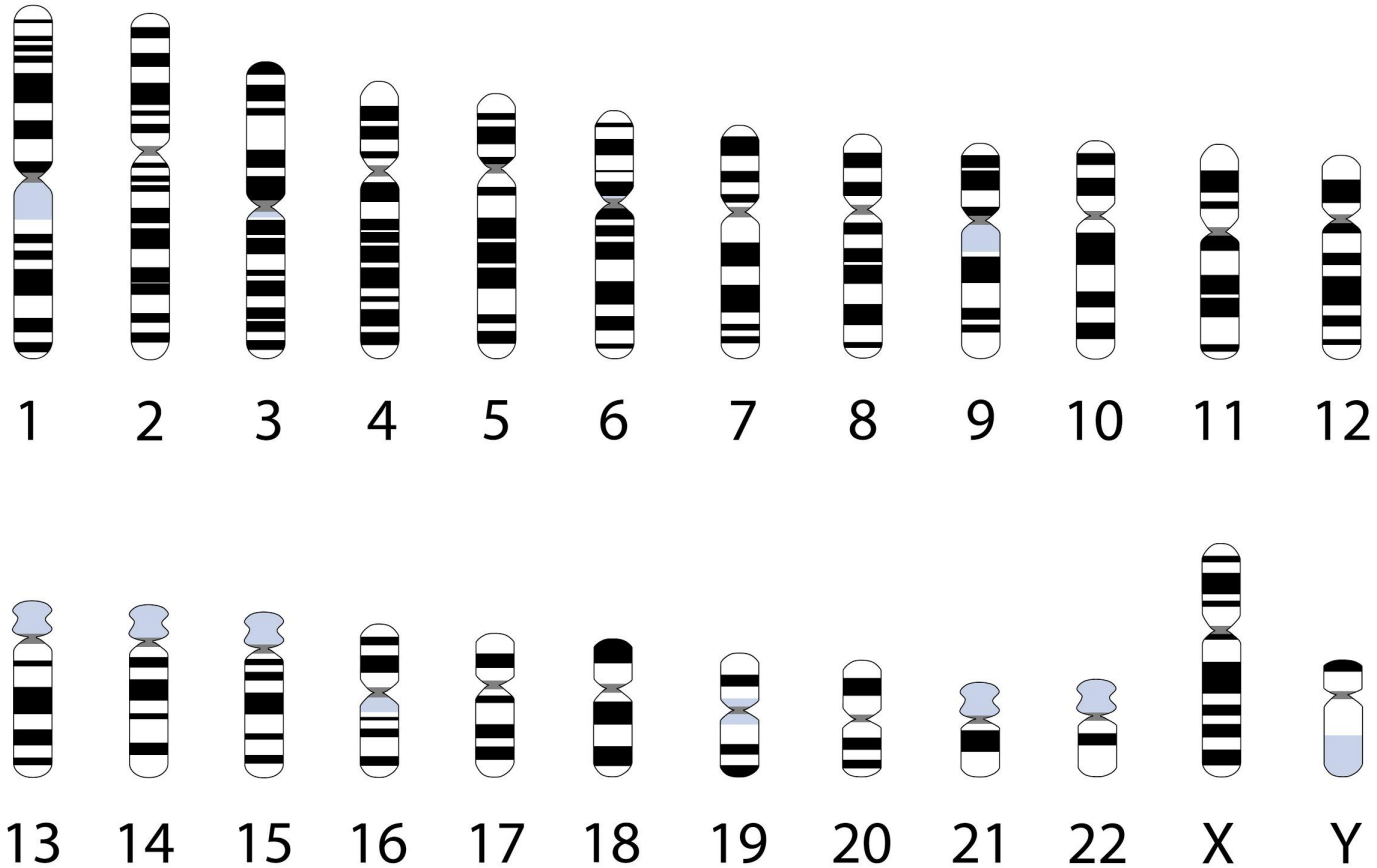
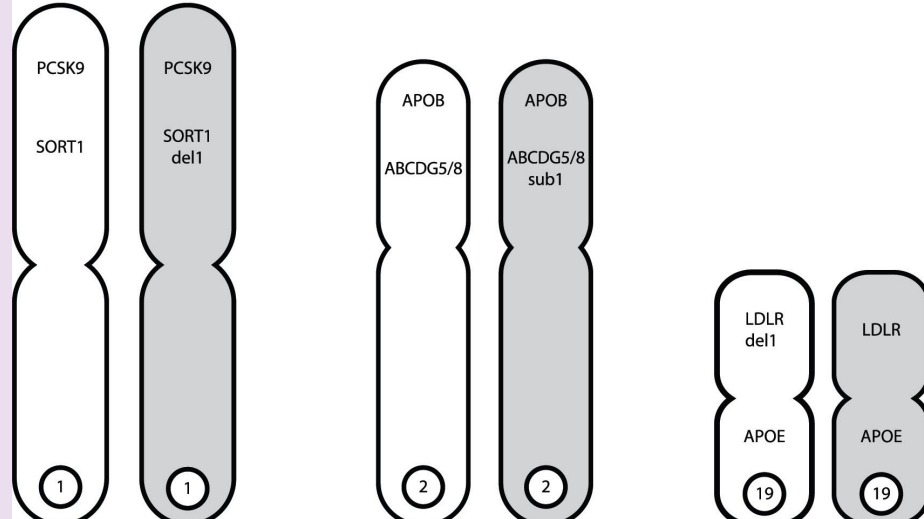@ Alila Medical Media/Shutterstock.com

STOP

With your group

Miles Parent 1 (Faith Miles)

One pair gets chromosomes
that represent Parent 1

Miles Parent 2 (Lee Miles)

One pair gets chromosomes
that represent Parent 2

J

With your group

Locate the following in your set of chromosomes

- A pair of chromosome 1
- A pair of chromosome 2
- A pair of chromosome 19
- One shaded and one plain copy of each chromosome in the pair (to make them easy to tell apart)
- Two different genes indicated on each chromosome
- Alleles of the genes are indicated
- A bunch of extra chromosomes (set these aside for now)
- A guide with information about what effect the different alleles have on LDL cholesterol levels

K

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With your class

Why are the chromosomes patterned differently?
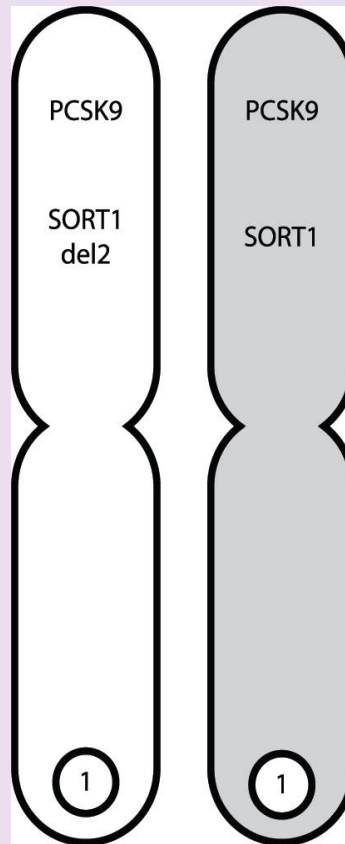
What is being indicated by the allele descriptions written on the chromosomes?
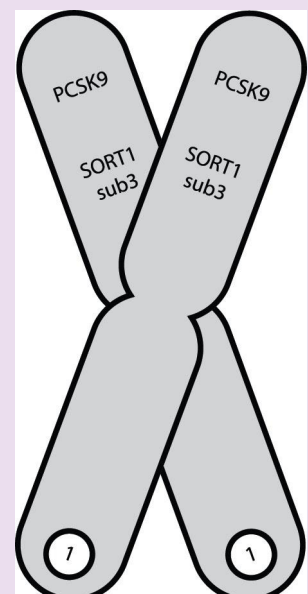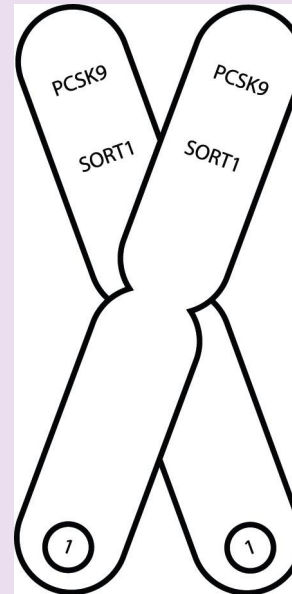
L

With your partner

You notice that you seem to have an extra set of chromosomes! Those are the copies that were made before the cell started to undergo meiosis. We can show this by putting them together to look like an X.

Parent 1 chromosomes
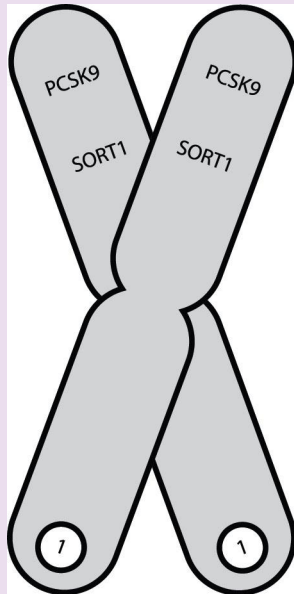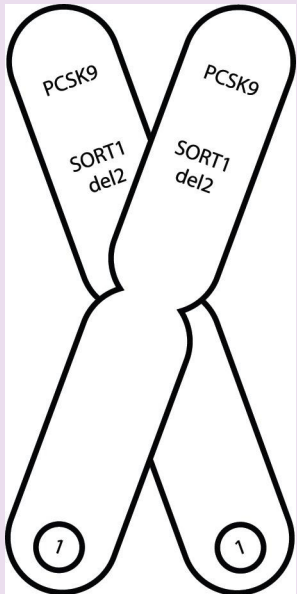
Parent 2 chromosomes

M

With your partner

Next, arrange the chromosomes so they show **they've been copied and are lined up with the chromosome that has alleles for the same genes.**

When you're ready, raise your hand for a quick check.

Then move on to arrange your chromosomes so they show **the first cellular division.**

When you're ready, raise your hand for a quick check.

Finally, arrange them so they show **the second cellular division and the resulting gametes.**

N

👥 With your group

In the table on your student sheet, record the alleles that are possible in the four gametes for the parent you and your partner have modeled.

Then find out what the partners who modeled the other parent had for their four gametes and record those alleles in the table.

Table 1

Results of Meiosis for Chromosome _ _ _ _ _							
Parent 1: Possible alleles in gametes (eggs)				Parent 2: Possible alleles in gametes (sperm)			

O

With your class

Table 1—for Miles family

Results of Meiosis for Chromosome — — — — 19 — — —						
Parent 1: Possible alleles in gametes (eggs)^					Parent 2: Po... gametes...	
LDLR	LDLR	LDLRdel1	LDLRdel1		LDLRdel1	LDLRdel1
APOE	APOE	APOE	APOE		APOE	APOE

Table 1—for Robinson family

Results of Meiosis for Chromosome — — — — 1 — — —						
Parent 1: Possible alleles in gametes (eggs)^					Parent 2: Po... gametes...	
PCSK9	PCSK9	PCSK9	PCSK9		PCSK9	PCSK9
SORT1sub3	SORT1sub3	SORT1	SORT1		SORT1	SORT1

P

With your class

Table 1—for Miles family

Results of Meiosis for Chromosome – – – – – 19 – – – – –								
Parent 1: Possible alleles in gametes (eggs)[A]					Parent 2: Possible alleles in gametes (sperm)[A]			
LDLR	LDLR	LDLRdel1	LDLRdel1		LDLRdel1	LDLRdel1	LDLR	LDLR
APOE	APOE	APOE	APOE		APOE	APOE	APOE	APOE

Table 2—for Miles family

| Allele arrangements in possible offspring (genotype)[B]	Proteins produced[C]	Is LDL level high or in the healthy range?* (phenotype)
LDLR/LDLR APOE/APOE	Typical functioning LDL receptor protein Typical APOE protein	HEALTHY RANGE
LDLR/LDLRdel1 APOE/APOE	Some disrupted-function LDL receptor protein is made Typical APOE protein	HIGH

Q

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👥 With your class

Table 1—for Miles family

Results of Meiosis for Chromosome – – – – 19 – – – –								
Parent 1: Possible alleles in gametes (eggs)[A]					Parent 2: Possible alleles in gametes (sperm)[A]			
LDLR	LDLR	LDLRdel1	LDLRdel1		LDLRdel1	LDLRdel1	LDLR	LDLR
APOE	APOE	APOE	APOE		APOE	APOE	APOE	APOE

LDLRdel1/LDLR APOE/APOE	Some disrupted-function LDL receptor protein is made Typical APOE protein	HIGH
LDLRdel1/LDLRdel1 APOE/APOE	Only disrupted function LDL receptor protein is made Typical APOE protein	VERY HIGH[D]

R

With your group

S
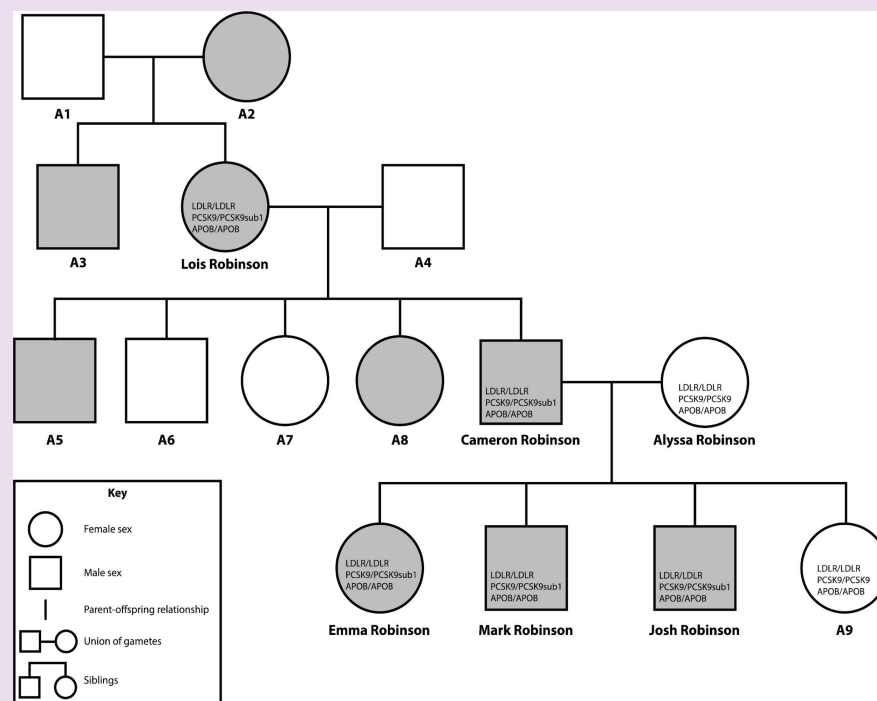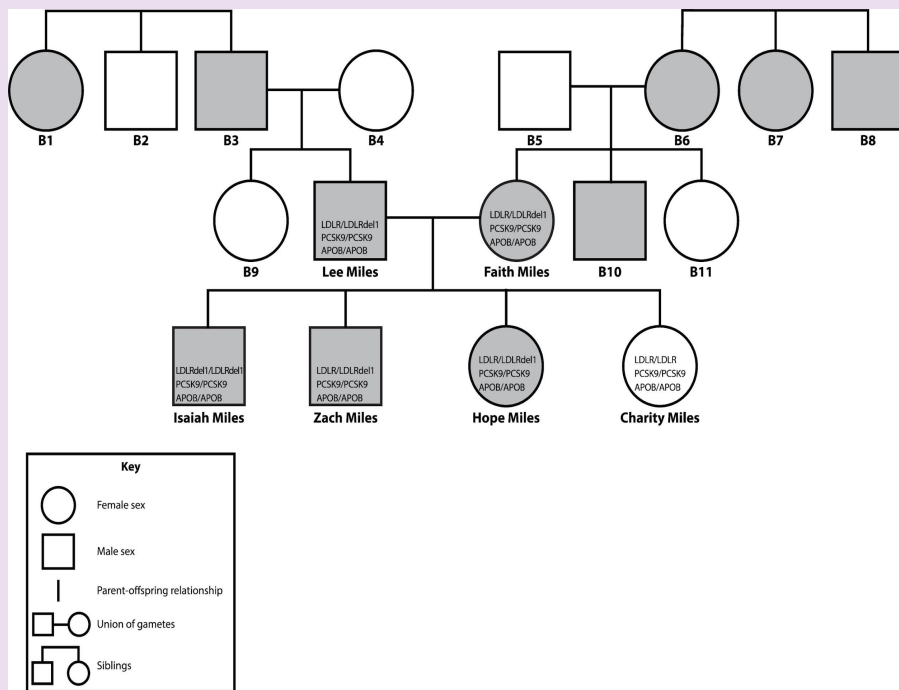
With your class

This is a complex system!
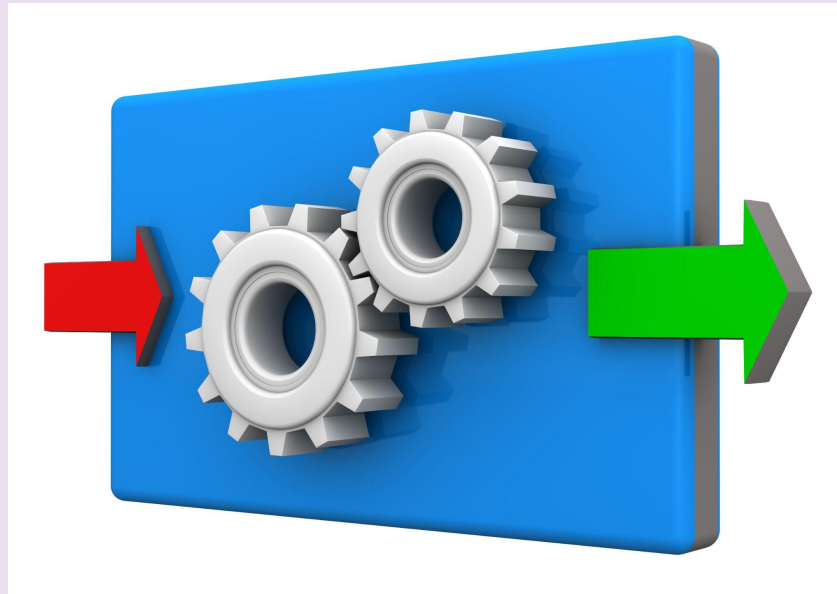
INPUTS → OUTPUTS

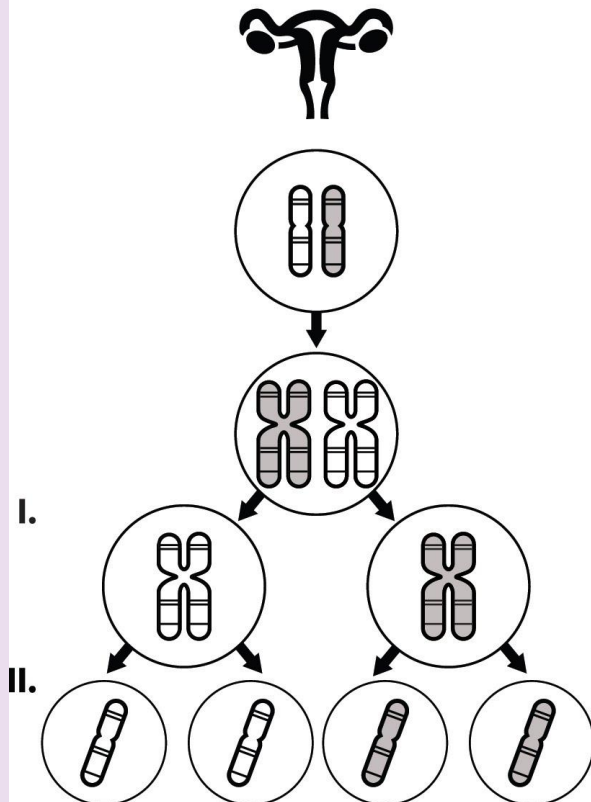© Alexander Limbach/Shutterstock.com

What have we figured out about the inputs, processes, and outputs of meiosis and fertilization?
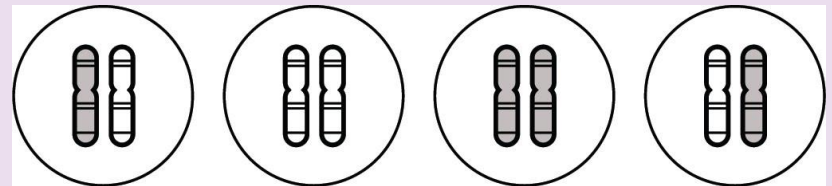
T

With your class

MEIOSIS

Model A: Meiosis in an Ovary

I.

II.

FERTILIZATION
leads to

U

Unit 2

Why do some people get heart disease and not others, and what can we do to prevent it?

Lesson 8
Day 2

With your class

Organize the following in your set of chromosomes

- A pair of chromosome 1
- A pair of chromosome 2
- A pair of chromosome 19
- One shaded and one plain copy of each chromosome in the pair (to make them easy to tell apart)
- An extra copy of each chromosome to use as the second copy of the chromosome that happens right before meiosis

How many different gametes could there be?

Record all the possible independent arrangements of chromosomes in gametes that could form during meiosis.
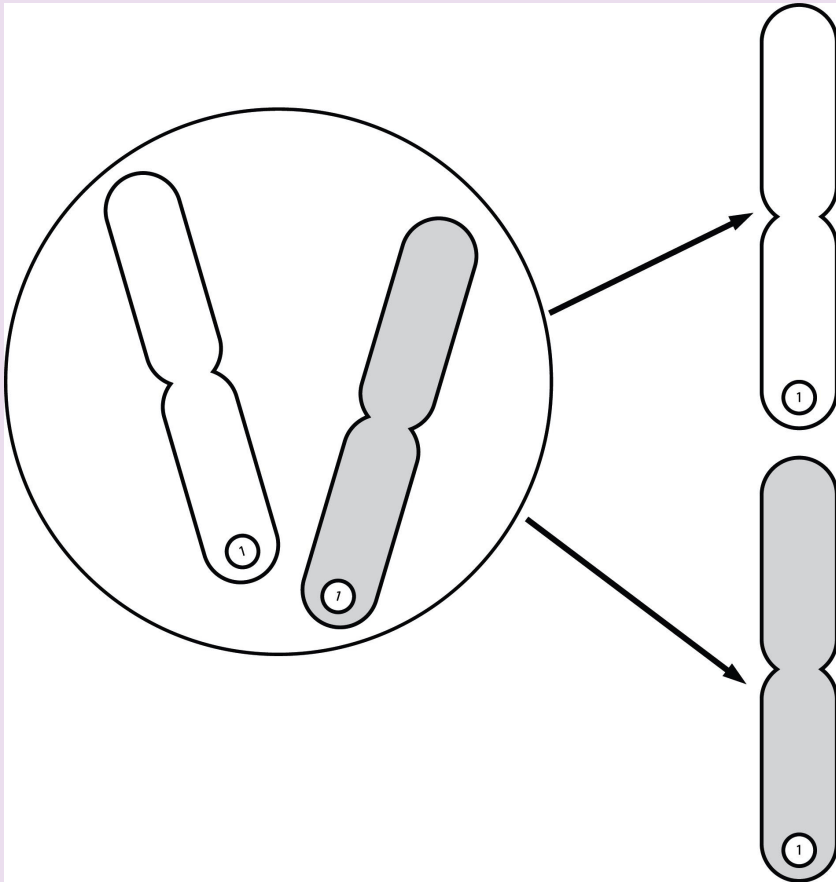
v

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👥 With your class

The number of possible different chromosome combinations (output) in gametes is 2^n, where n is the number of chromosome pairs (input)

$$2^1 = 2$$

2 different
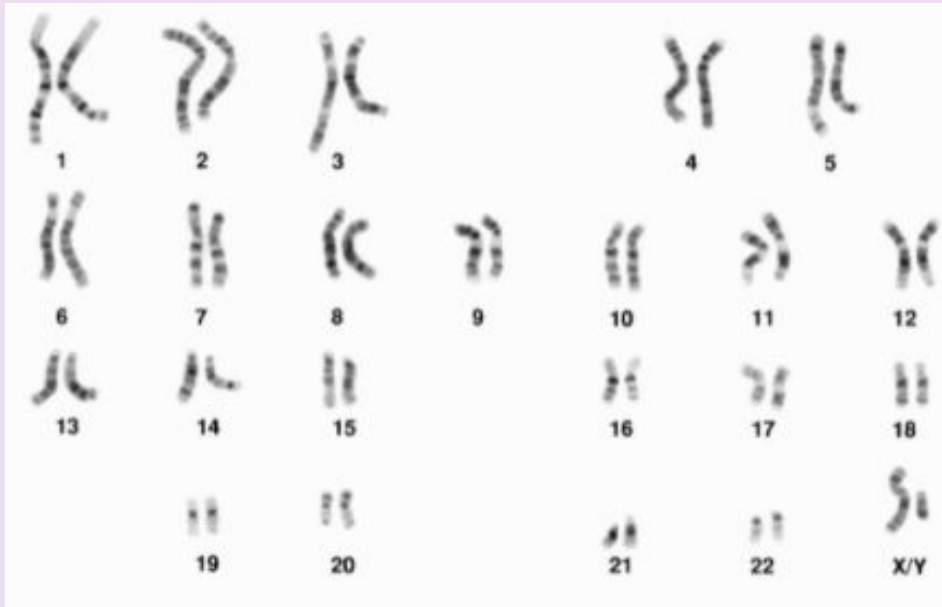possible gametes

With your class
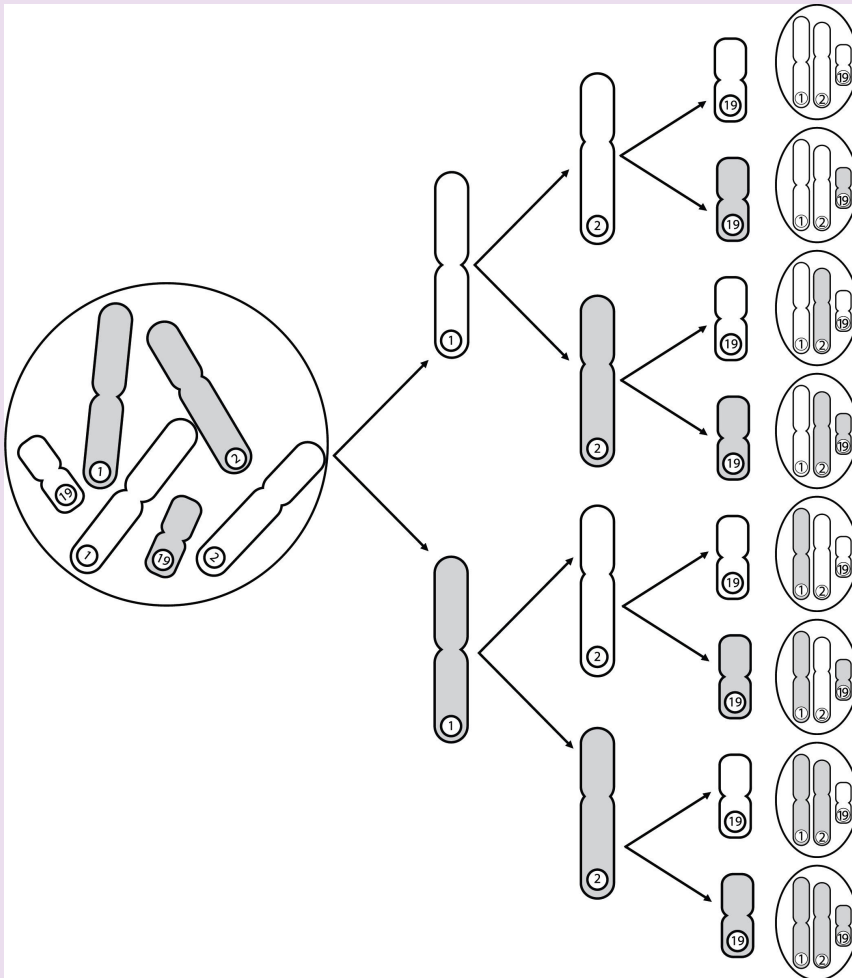
The number of possible different chromosome combinations (output) in gametes is 2^n, where n is the number of chromosome pairs (input)

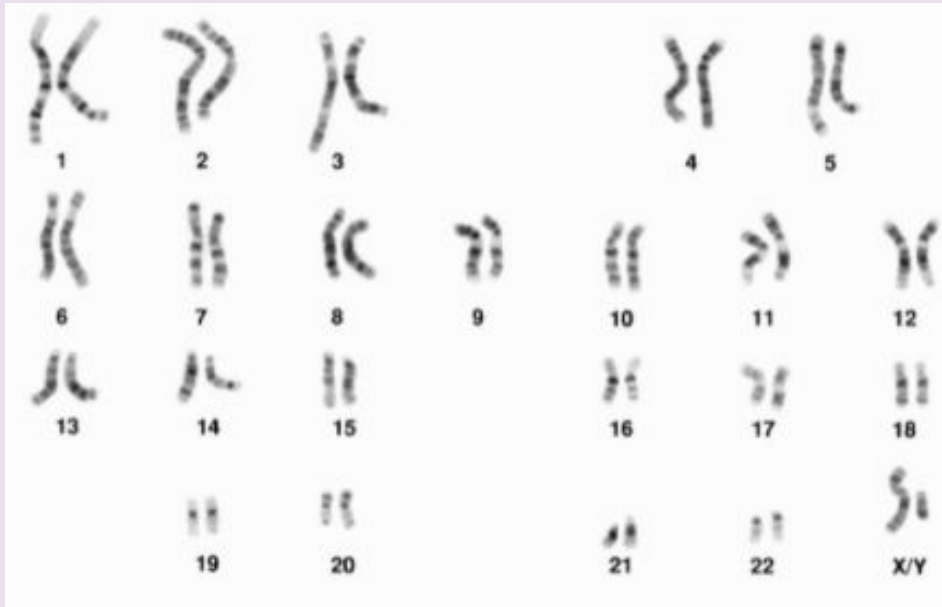$$2^3 = 8$$

8 different
possible gametes

X

With your class

@ Scott Camazine/Science Source

The number of possible different chromosome combinations (output) in gametes is 2^n, where n is the number of chromosome pairs (input)

$$2^{23} =$$

Y

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With your class

@ Scott Camazine/Science Source

The number of possible different chromosome combinations (output) in gametes is 2^n, where n is the number of chromosome pairs (input)

$$2^{23} = 8,388,608$$

8,388,608
different possible
gametes

Z

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With your group

What fertilizations could have resulted in one of your pedigree family siblings?

1. Pick one of the siblings from your pedigree.
2. Fill in that sibling's genotype for LDLR, PCSK9, and APOB genes on the **Genotypes of Offspring** Student Sheet (2.8.G).
3. Identify which of your parental chromosomes have those alleles.
4. We'll work through an example together.

STUDENT SHEET 2.8.G KEY

Page 1 of 1

Genotypes of Offspring

Name of sibling _____ Isaiah Miles _____

Known genotype of sibling:

For PCSK9: 2 typical alleles—PCSK9/PCSK9

For APOB: 2 typical alleles—APOB/APOB

For LDLR: 2 mutated alleles—LDLRdel1/LDLRdel1

AA

With your group

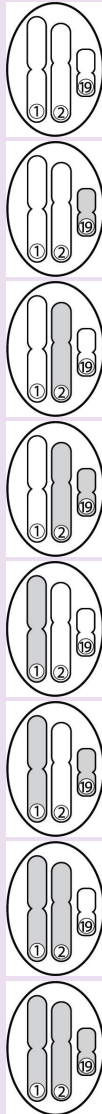Parent 1
gametes

Parent 2
gametes

Look at **chromosome 1**
- Which copy of chromosome 1 from each parent could combine to give that genotype for PCSK9?

BB

With your group

Parent 1 gametes

Parent 2 gametes
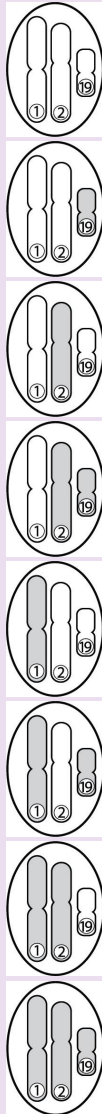
Look at **chromosome 1**

- Which copy of chromosome 1 from each parent could combine to give that genotype for PCSK9?

Either shaded or plain for Parent 1
Either shaded or plain for Parent 2

cc
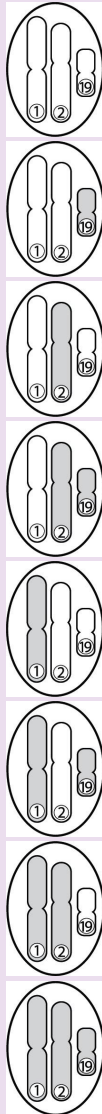
With your group

Parent 1 gametes
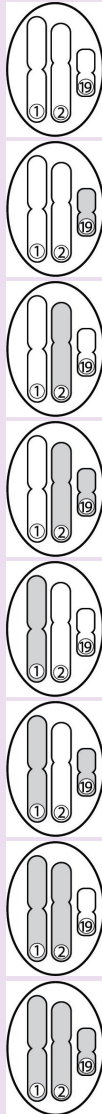

Parent 2 gametes

Look at **chromosome 1**

- Which copy of chromosome 1 from each parent could combine to give that genotype for PCSK9?
- Which gametes from each parent contain those chromosomes?

DD

With your group

Parent 1 gametes

Parent 2 gametes

Look at **chromosome 1**

- Which copy of chromosome 1 from each parent could combine to give that genotype for PCSK9?
- Which gametes from each parent contain those chromosomes?

All the gametes for Parent 1
All the gametes for Parent 2

EE

With your group

Parent 1 gametes

Parent 2 gametes

Look at **chromosome 1**

- Which copy of chromosome 1 from each parent could combine to give that genotype for PCSK9?
- Which gametes from each parent contain those chromosomes?
- Cross off any gametes that would not result in the correct genotype in the offspring.
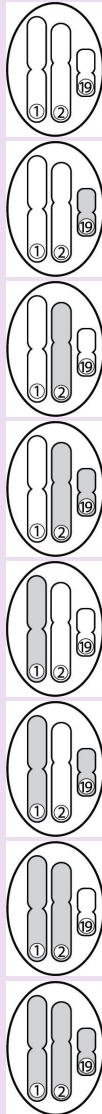
None

FF

With your group
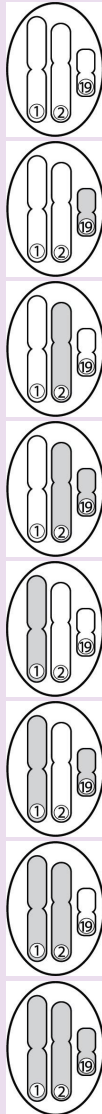
Parent 1 gametes

Parent 2 gametes

Look at **chromosome 2**
- Which copy of chromosome 2 from each parent could combine to give that genotype for APOB?

GG

With your group

Parent 1
gametes

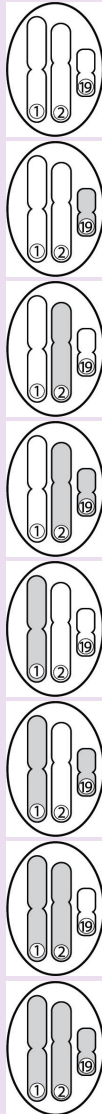Parent 2
gametes

Look at **chromosome 2**
- Which copy of chromosome 2 from each parent could combine to give that genotype for APOB?

Either shaded or plain for Parent 1
Either shaded or plain for Parent 2 HH

With your group

Parent 1
gametes

Parent 2
gametes

Look at **chromosome 2**
- Which copy of chromosome 2 from each parent could combine to give that genotype for APOB?
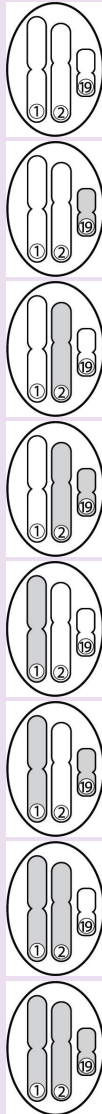- Which gametes from each parent contain those chromosomes?

All the gametes for Parent 1
All the gametes for Parent 2

II

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With your group

Parent 1 gametes

Parent 2 gametes

Look at **chromosome 2**

- Which copy of chromosome 2 from each parent could combine to give that genotype for APOB?
- Which gametes from each parent contain those chromosomes?
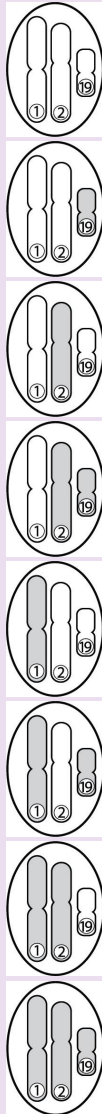- Cross off any gametes that would not result in the correct genotype in the offspring.

None

JJ

With your group
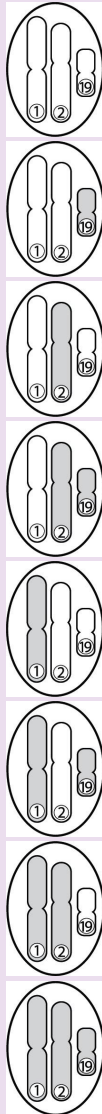
Parent 1 gametes

Parent 2 gametes

Look at **chromosome 19**

- Which copy of chromosome 19 from each parent could combine to give that genotype for LDLR?

KK

With your group

Parent 1
gametes

Parent 2
gametes

Look at **chromosome 19**

- Which copy of chromosome 19 from each parent could combine to give that genotype for LDLR?
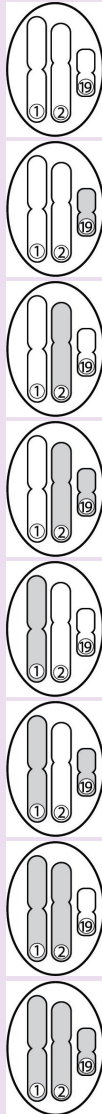
Shaded one from Parent 1
Plain one from Parent 2

With your group

Parent 1 gametes

Parent 2 gametes

Look at **chromosome 19**

- Which copy of chromosome 19 from each parent could combine to give that genotype for LDLR?
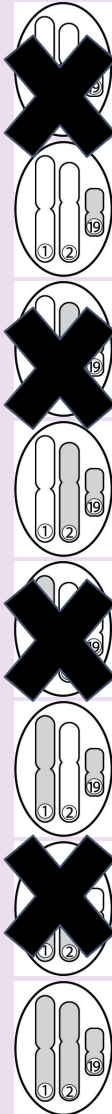- Which gametes from each parent contain those chromosomes?

4 of the gametes for Parent 1
4 of the gametes for Parent 2

MM

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With your group

Parent 1 gametes

Parent 2 gametes
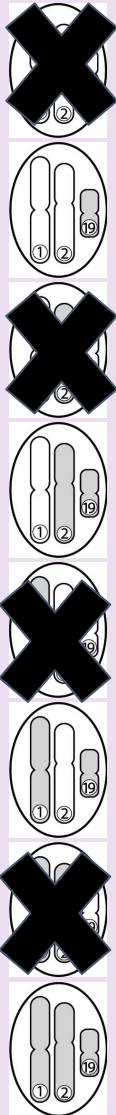
Look at **chromosome 19**

- Which copy of chromosome 19 from each parent could combine to give that genotype for LDLR?
- Which gametes from each parent contain those chromosomes?
- Cross off any gametes that would not result in the correct genotype in the offspring.
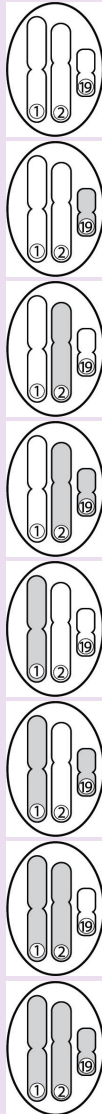
NN

With your group

Parent 1 gametes

Parent 2 gametes

Gamete combinations in FERTILIZATION	
Parent 1 gamete	Parent 2 gamete

With your class

Parent 1 gametes

Parent 2 gametes

What if we weren't looking for a specific genotype . . .

How many total possible combinations could there be?

With your class

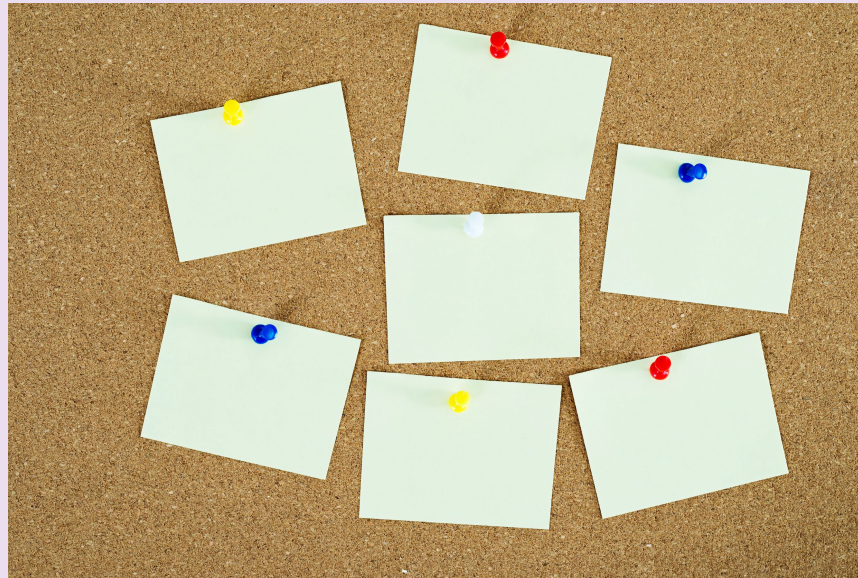**How many total possible combinations could there be?**

For humans:
8,388,608 possible gametes

$$8{,}388{,}608^2 = \mathbf{70{,}368{,}744{,}177{,}664}$$

BSCS SCIENCE LEARNING   Kendall Hunt

With your class

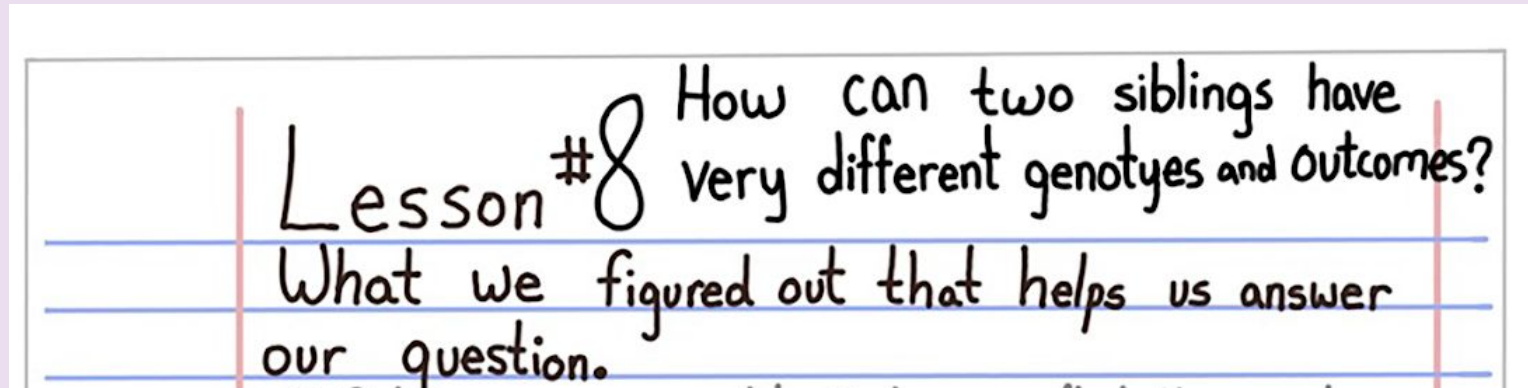## What words do we want to add to the Word Wall?

© Shutterstock.com

RR

With your class/Turn and talk

What did we figure out in this lesson?

Lesson #8 How can two siblings have very different genotyes and outcomes?

What we figured out that helps us answer our question.

SS

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With your class