Lecture 5: Finish Meiosis + Start Patterns of Inheritance - Mendelian Genetics – Autosomal Dominant and Autosomal Recessive modes of inheritance.

Update on questions – still working on it…

From Dr. Pam Kalas:

1. Variables that can affect rate of cell division?:

"definitely temperature, but cell type, species, molecule stimuli/signals….and probably a lot more."

2. Negative consequences of crossing-over:

Crossing-over is necessary for meiosis to occur. It is what holds homologous chromosomes together. So, I don't think we could ever say that it (crossing-over) can ever have negative effects on meiosis. There can be mistakes in the process (like in every process), and that can be problematic for the cell; but, any process that goes wrong can cause problems and we would not say that such processes can have negative effects; rather, their going wrong can have negative effects.

3. Why do we have 23 pairs of chromosomes of different chromosomal lengths:

"23 pairs is really chance; that's how evolution turned out. Why would they differ in chromosomal length? Why would they not differ? It would be a heck of a lot more unlikely that, due to chance, they were all the same length. During evolution, chromosomes break, fuse and rearrange (often due to chance events). So, it is not surprising that they are all different lengths.

If I haven't yet answered your question, can you please email me a reminder (lnorman@zoology.ubc.ca). I know I have forgotten some of the awesome questions that you asked.

Study tip #7- Try to avoid multitasking when studying

ELSEVIER

Computers in Human Behavior

Volume 29, Issue 3, May 2013, Pages 948-958

Facebook and texting made me do it: Media-induced task-switching while studying

Larry D. Rosen, L. Mark Carrier, Nancy A. Cheever

Show more

https://doi.org/10.1016/j.chb.2012.12.001 Get rights and content

In this study, researchers monitored the study habits of students in 15 minute time blocks.

If a distractor (e.g. cell phone) was nearby, how long were the students able to focus on studying before becoming distracted?

< 6 minutes, and students who had distractors nearby had lower GPAs

Promised citation

Sleep Loss Promotes Astrocytic Phagocytosis and Microglial Activation in Mouse Cerebral Cortex

Michele Bellesi, Luisa de Vivo, Mattia Chini, Francesca Gilli, Giulio Tononi, and Chiara Cirelli

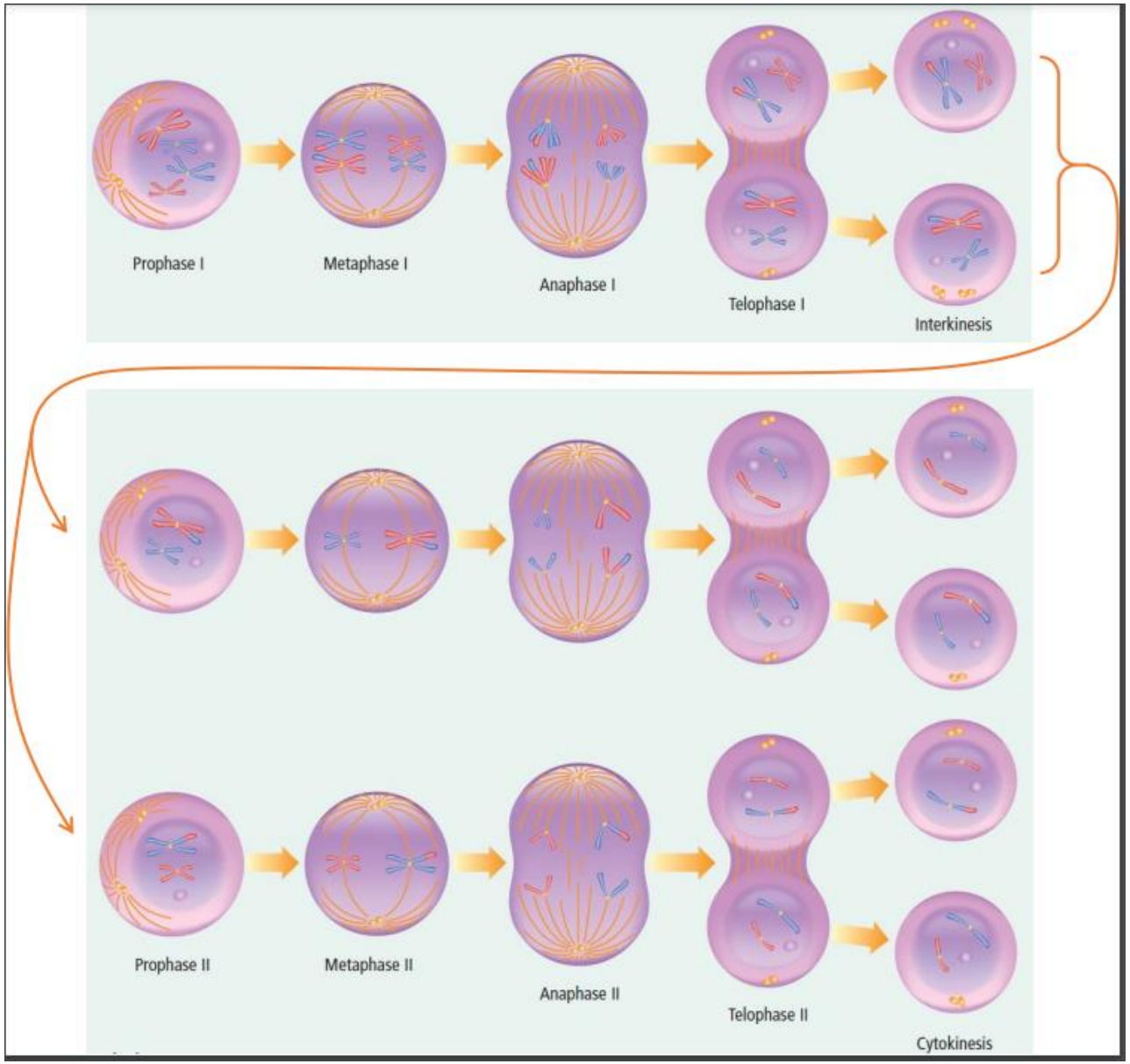
Journal of Neuroscience 24 May 2017, 37 (21) 5263-5273; DOI: https://doi.org/10.1523/JNEUROSCI.3981-16.2017

“Researchers have found that persistently poor sleep causes the brain to clear a significant amount of neurons and synaptic connections, and recovering sleep might not be able to reverse the damage.”

Pam’s genetics survey (1%)

- Now open until this Thursday night @ 11:59 pm
- Pam said the response so far has been outstanding. She said THANK YOU!

Last class – started Meiosis



Source: Courtney Cheung

Meiosis: Learning Objectives

Be able to draw/label/identify:

- A cell in the different stages of meiosis:
  - Genes, alleles, homologous chromosomes, sister and non-sister chromatids
  - Be able to work forwards and backward through meiosis. For example, if I give the genotype of a parent and one gamete, you should be able to draw the cell at Metaphase I (see Ice Spider Worksheet – Optional Genetics Worksheets)

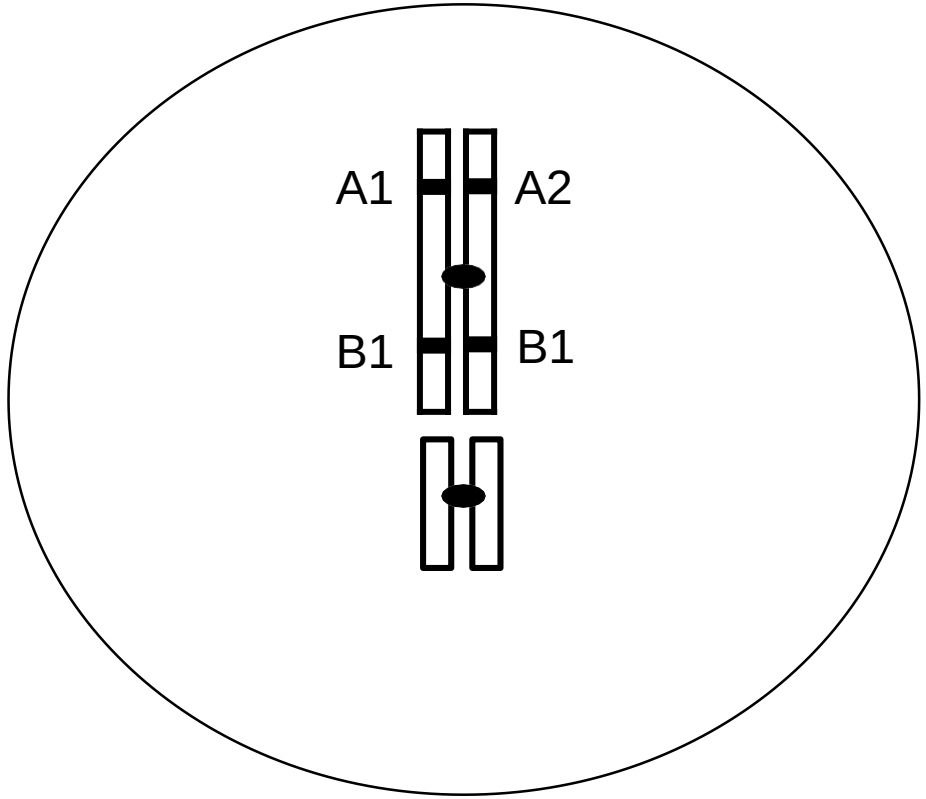
Be able to explain and/or describe:

- How ploidy, number of chromatids and number of DNA molecules change throughout meiosis.
- Similarities and differences with mitosis
- How genetic variation arises, including the cellular mechanisms responsible (and the scale of variation, e.g. genes, chromosomes, gametes, individuals)
  - Crossing over & genetic recombination (Prophase I)
  - Independent assortment of homologous chromosomes (Metaphase I)
  - Random fusion of gametes
- Note – this also includes how alleles arise.
- Be able to predict:
  - the possible genotype combinations of cells produced by meiotic divisions given information on the genotype of one or more diploid cells

iClicker Question

- This is the cell of a diploid organism with a genotype of A1/A2; B1/B2. Is this cell in metaphase of mitosis or Metaphase I or Metaphase II?

A. Metaphase (Mitosis)
B. Metaphase I
C. Metaphase II
D. None of the above
E. Not sure



Could you explain why?

Answer

- This is the cell of a diploid organism with a genotype of A1/A2; B1/B2. Is this cell in Metaphase of mitosis or Metaphase I or Metaphase II?

A. Metaphase (Mitosis)
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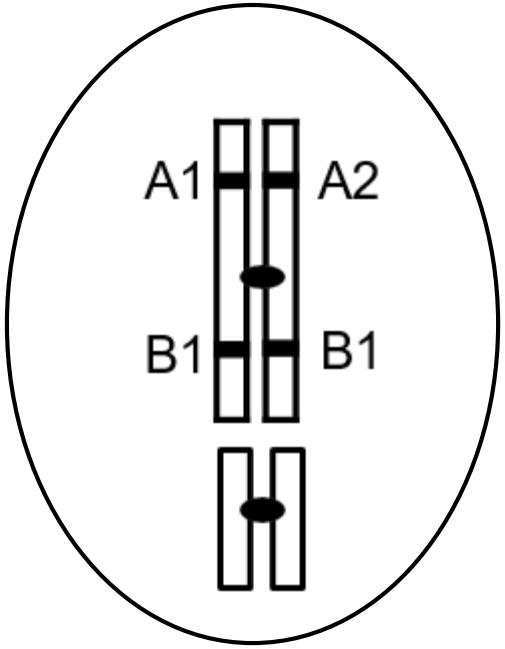
C. Metaphase II
D. None of the above
E. Not sure



Must be metaphase II because cell is now haploid; i.e. homologous chromosomes have already separated in M1; and sister chromatids aligned at metaphase plate

If cell was at metaphase I – cell would still be diploid, and homologous chromosomes would be aligned at metaphase plate..

Cannot be mitosis:
- *cell is haploid not diploid*
- *Crossing-over has occurred (a sign of meiosis)*
- *Gamete genotypes would not be identical to each other or parent cell (A1B1, A2B1, and A1A2B1B2)*

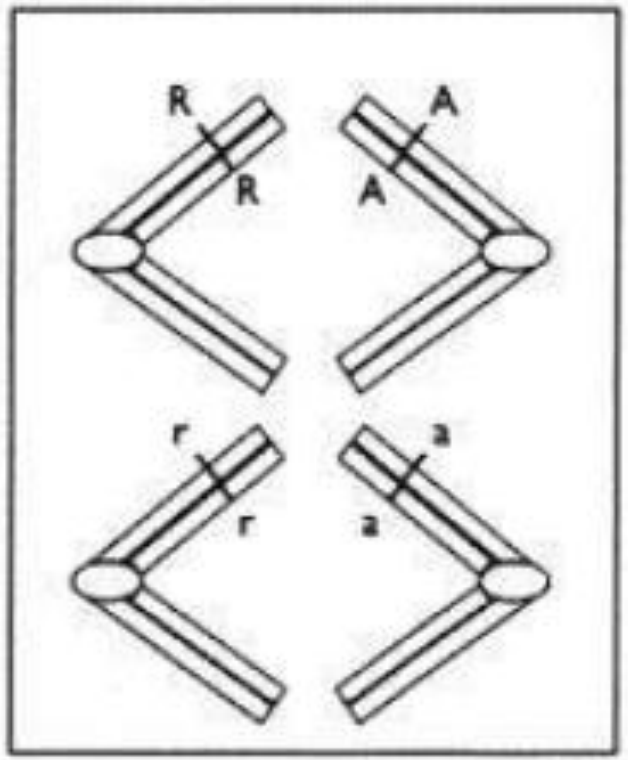
Could you explain why?

iClicker Question (question a from worksheet #3)

The diagram below shows a cell of a diploid organism that is heterozygous for two genes. The parent cell was a 2n=4 cell with the genotype AaRr. Genes are on different chromosomes (please ignore the fact that all 4 chromosomes are the same size and have the same centromere location for this question).

Is this cell in Anaphase of:

A. Mitosis
B. Meiosis I
C. Meiosis II
D. Not possible
E. Not sure



Answer

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D. Not possible
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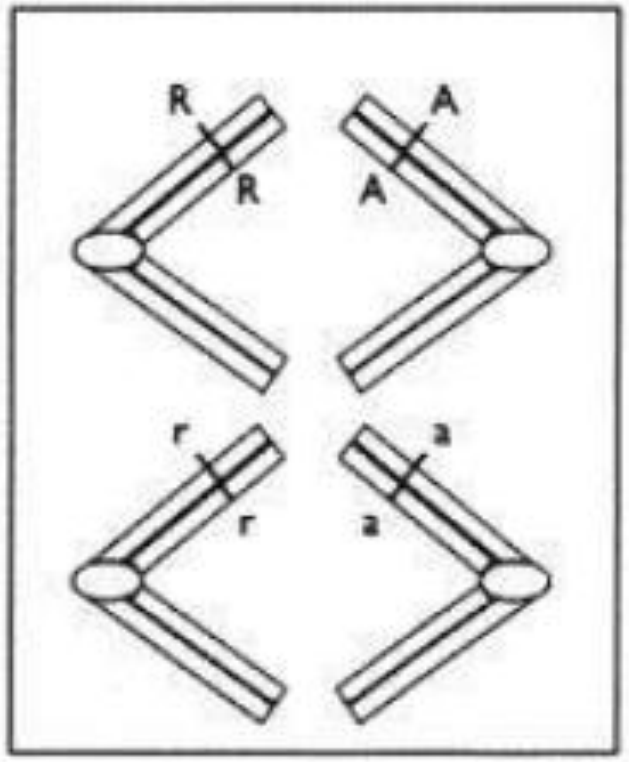


- Non-homologous chromosomes are pulling away from each other; so, not Mitosis and not Anaphase I or Anaphase II.

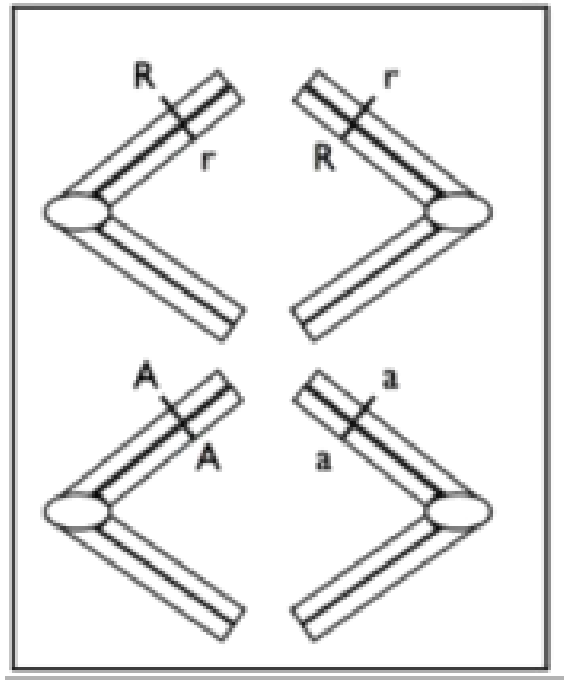
- Sister chromatids are still attached; so, not Anaphase II, nor mitosis.

iClicker Question (question b from worksheet #3)

The diagram below shows a cell of a diploid organism that is heterozygous for two genes. The parent cell was a 2n=4 cell with the genotype AaRr. Genes are on different chromosomes (please ignore the fact that all 4 chromosomes are the same size and have the same centromere location for this question).

Is this cell in Anaphase of:

A. Mitosis
B. Meiosis I
C. Meiosis II
D. Not possible
E. Not sure



Answer

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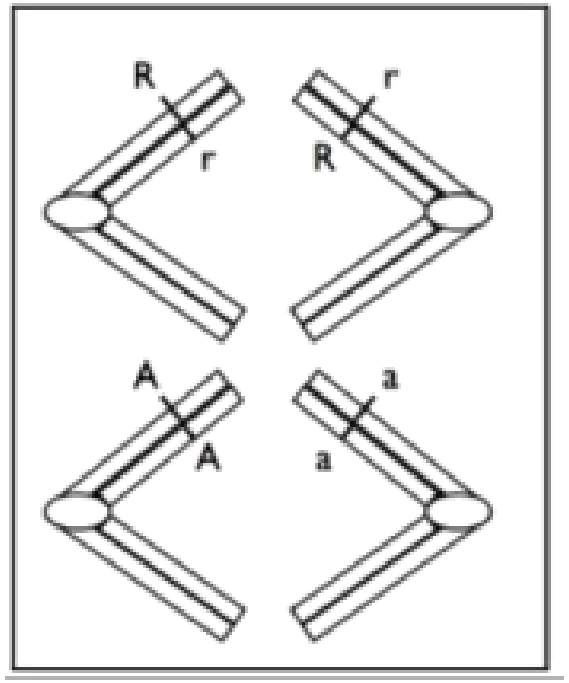
Is this cell in Anaphase of:

A. Mitosis
B. Meiosis I
C. Meiosis II
D. Not possible
E. Not sure



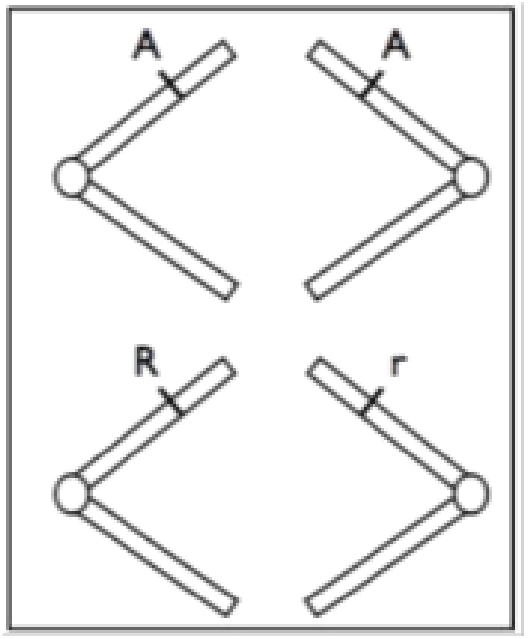
- Anaphase I of Meiosis because: homologous chromosomes are pulling apart; cell is currently diploid, but will be haploid by the end of nuclear division, and crossing-over and recombination of the R gene has occurred; these are all signs of Meiosis I.
- Cannot be Anaphase of Mitosis because daughter cells would not be genetically identical to each other, nor to parent cell (AA, aa, Rr, Rr versus AaRr).
- Cannot be Anaphase II because sister chromatids are still attached.

iClicker Question (question c from worksheet #3)

The diagram below shows a cell of a diploid organism that is heterozygous for two genes. The parent cell was a 2n=4 cell with the genotype AaRr. Genes are on different chromosomes (please ignore the fact that all 4chromosomes are the same size and have the same centromere location for this question).

Is this cell in Anaphase of:

A. Mitosis
B. Meiosis I
C. Meiosis II
D. Not possible
E. Not sure

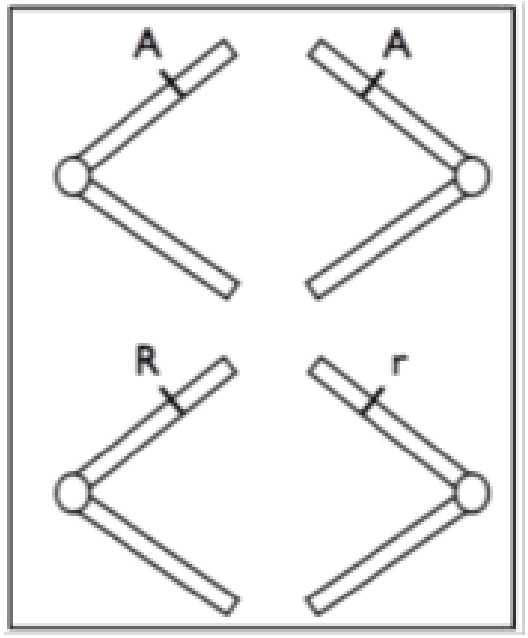


Answer

The diagram below shows a cell of a diploid organism that is heterozygous for two genes. The parent cell was a 2n=4 cell with the genotype AaRr. Genes are on different chromosomes (please ignore the fact that all 4 chromosomes are the same size and have the same centromere location for this question).

Is this cell in Anaphase of:

A. Mitosis
B. Meiosis I
C. Meiosis II
D. Not possible
E. Not sure



Anaphase II because cell is haploid, and sister chromatids are separating; sister chromatids do not contain same alleles, which are signs of Anaphase II.

Cannot be Anaphase I because cell is haploid, not diploid; homologous chromosomes are missing.

Cannot be mitosis because daughter cells will not be genetically identical to each other or parent cell (AA, Rr, AaRr). Also, sister chromatids are not identical to each other; they carry different alleles for the R gene.

iClicker Question (question d from worksheet #3)

The diagram below shows a cell of a diploid organism that is heterozygous for two genes. The parent cell was a 2n=4 cell with the genotype AaRr. Genes are on different chromosomes (please ignore the fact that all 4chromosomes are the same size and have the same centromere location for this question).

Is this cell in Anaphase of:

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C. Meiosis II
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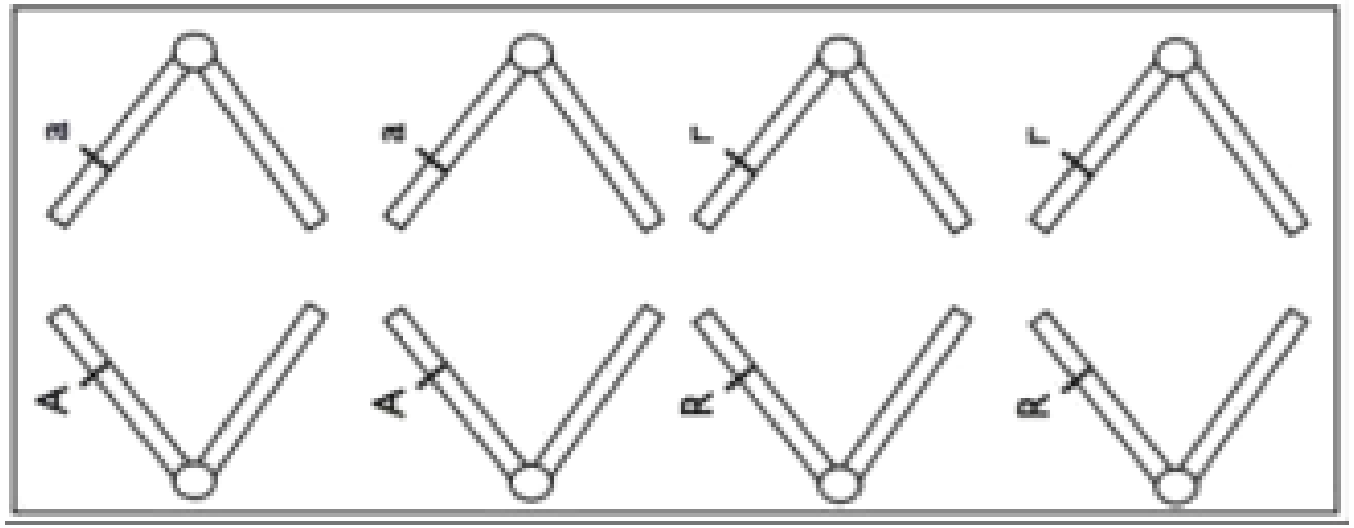

Answer

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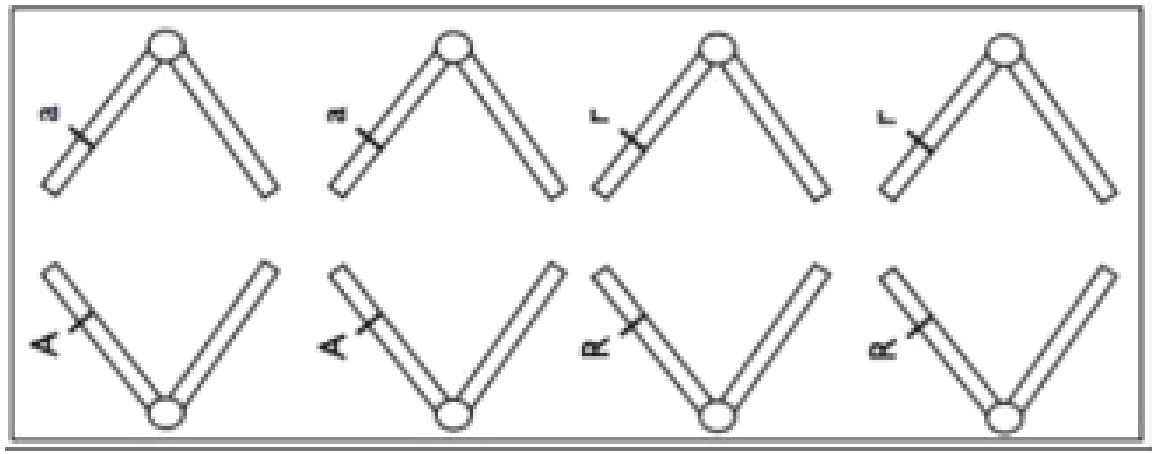
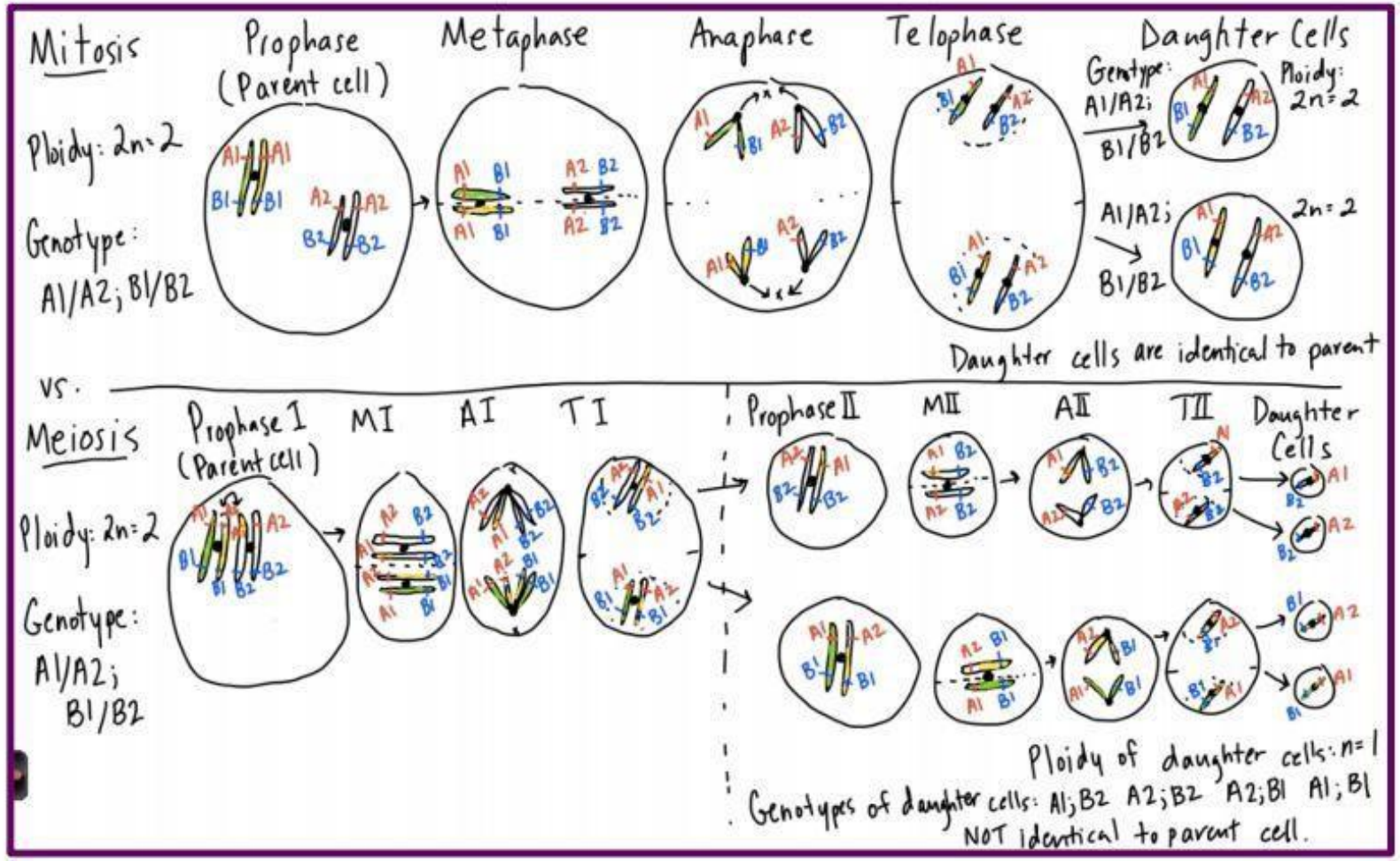


- Cannot be Anaphase of mitosis because daughter cells would not be identical to each other or parent cell (e.g. AARR and aarr, not AaRr).
- Cannot be Anaphase I because sister chromatids instead of homologs are separating from each other, and the two progeny cells will be diploid, not haploid
- Cannot be Anaphase II because, although sister chromatids are separating, the cell is diploid, and will produce diploid gametes/daughter cells rather than haploid gametes.

Comparison of mitosis & meiosis (follow alleles)

Awesome video from Dr. Erica Jeffrey (121 Instructor) on Canvas > Genetics – Additional Materials > Mitosis & Meiosis.mp4



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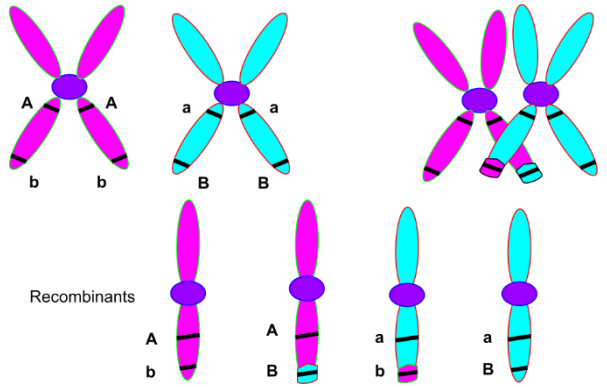
  - Random fusion of gametes
- Note – this also includes how alleles arise.
- Be able to predict:
  - the possible genotype combinations of cells produced by meiotic divisions given information on the genotype of one or more diploid cells

One source of genetic variation

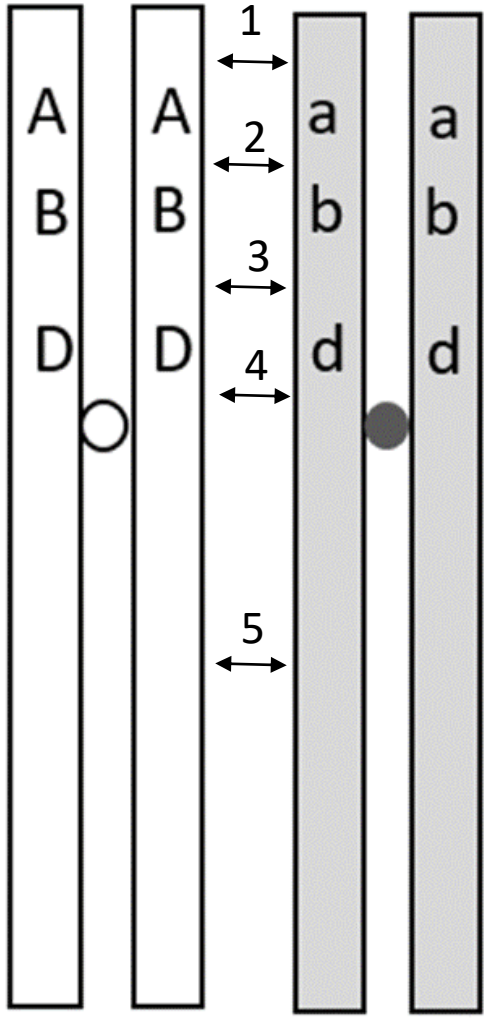
Crossing-over and recombination

- when: late prophase I
  - Outcome: Chromosomes contain a random assortment of paternal and maternal alleles (crossing-over happens between non-sister chromatids of homologous chromosomes)



source:
http://iws.collin.edu/biopage/faculty/mcculloch/1406/notes/meiosis/independ%20assort.htm

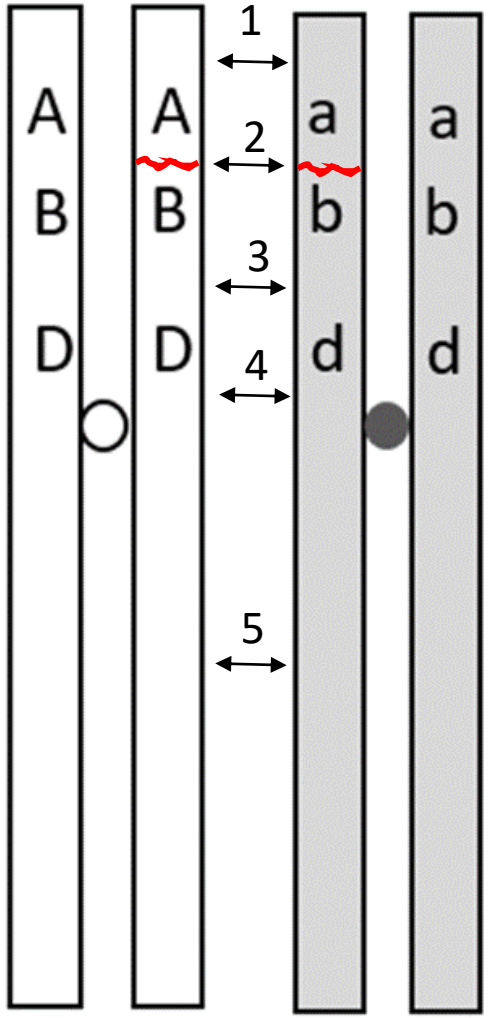
iClicker Question



Where would the DNA need to break to create a chromatid with the genotype Abd?

A. 1
B. 2
C. 3
D. 2 and 3
E. 3 and 4

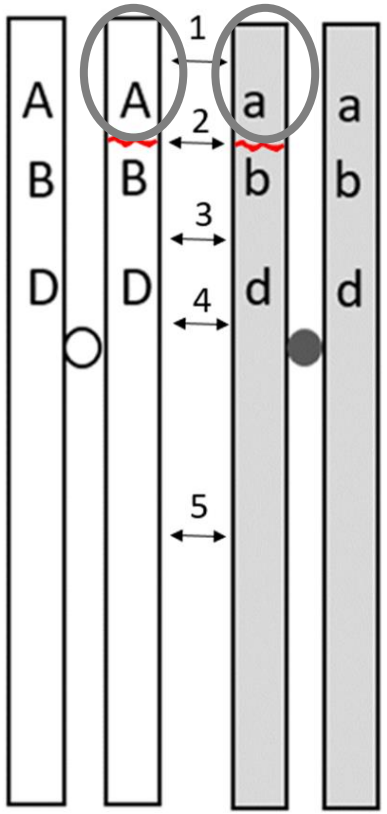
Answer

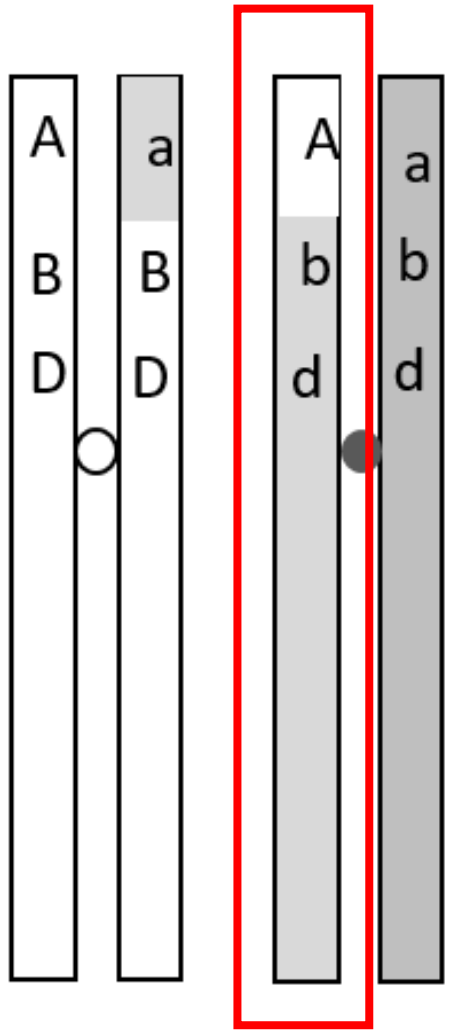


Where would the DNA need to break to create a chromatid with the genotype Abd?

A. 1
B. 2
C. 3
D. 2 and 3
E. 3 and 4

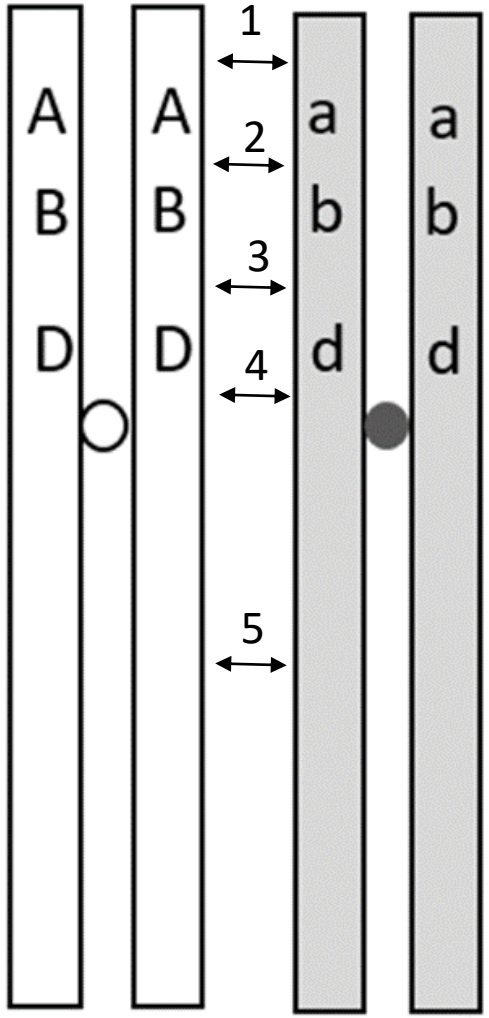
Answer continued





Where the DNA would need to break to create the genotype Abd.

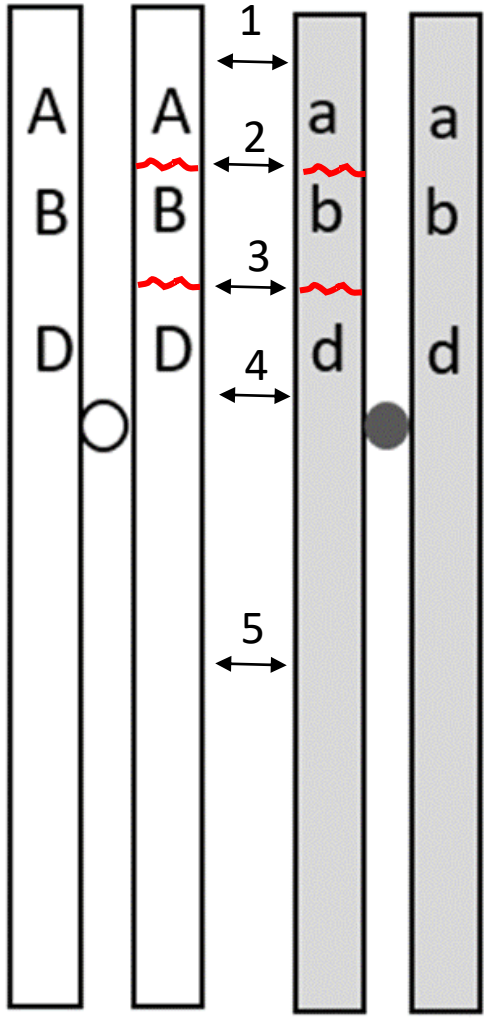
iClicker Question



Where would the DNA need to break to create a chromatid with the genotype AbD?

A. 1
B. 2
C. 3
D. 2 and 3
E. 3 and 4

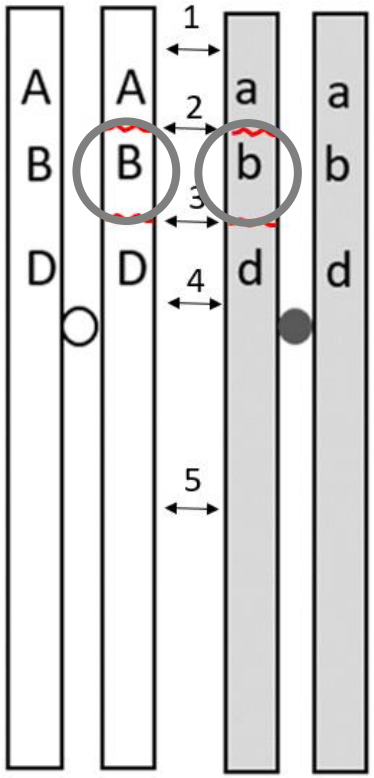
Answer

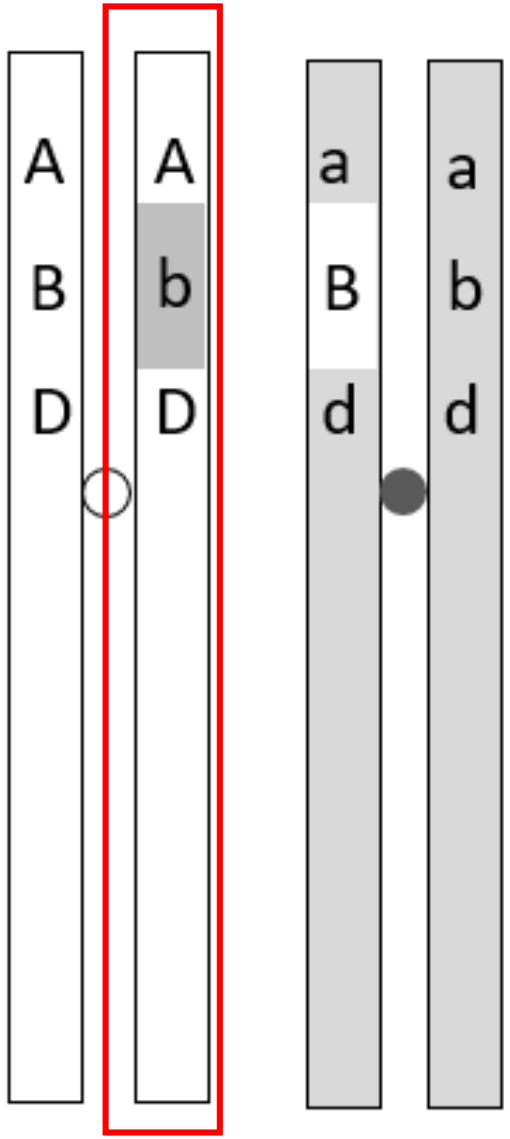


Where would the DNA need to break to create a genotype with the genotype AbD?

A. 1
B. 2
C. 3
D. 2 and 3
E. 3 and 4

Answer continued





Where would the DNA need to break to create the genotype AbD?

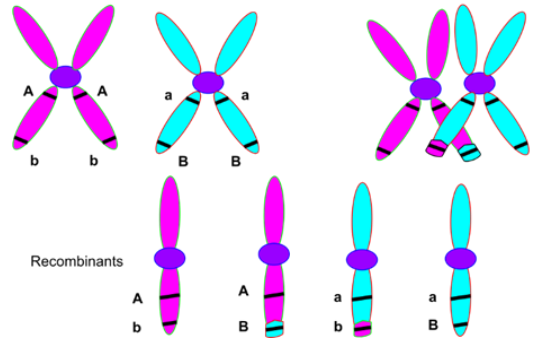
Crossing-over & recombination – Nature's solution to physical linkage

From Dr. Craig Berezowsky:

- In an ideal, theoretical world every gene would be on its own chromosome so that it could assort independently of the other genes. This would maximize genetic variation.

- But, this is not possible. You have ~20,000 genes on 23 pairs of chromosomes; so, most genes are going to be physically linked to other genes.

- Nature's solution to this linkage is crossing-over, which breaks up linkages between genes on the same chromosome and allows for recombination of alleles during Prophase I.

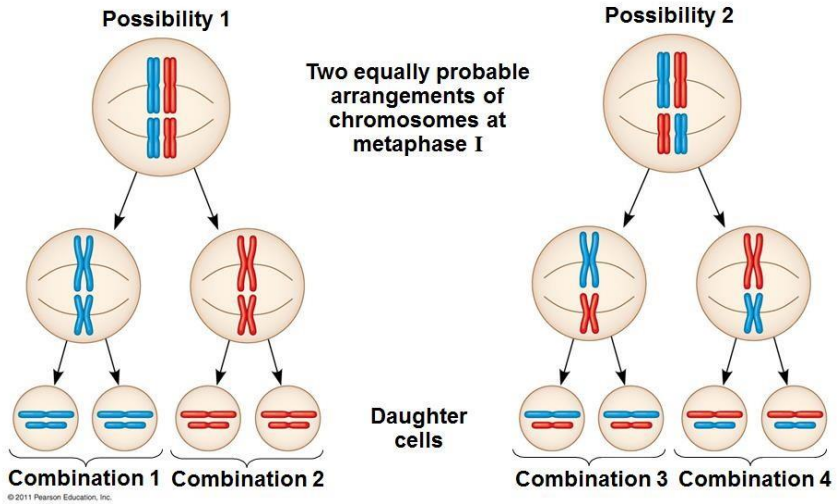


2nd source of genetic variation

Independent assortment of homologous chromosomes

When - @ Metaphase I

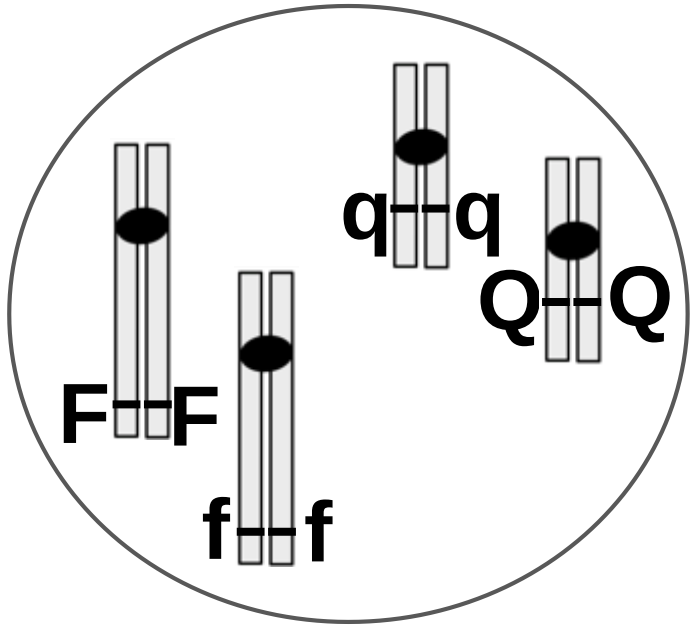
- Outcome: Gametes receive a random assortment of maternal and paternal chromosomes (and their alleles).
- 2^n (n=number of homologous pairs)



source:
http://iws.collin.edu/biopage/faculty/mcculloch/1406/notes/meiosis/independ%20assort.htm

iClicker Question

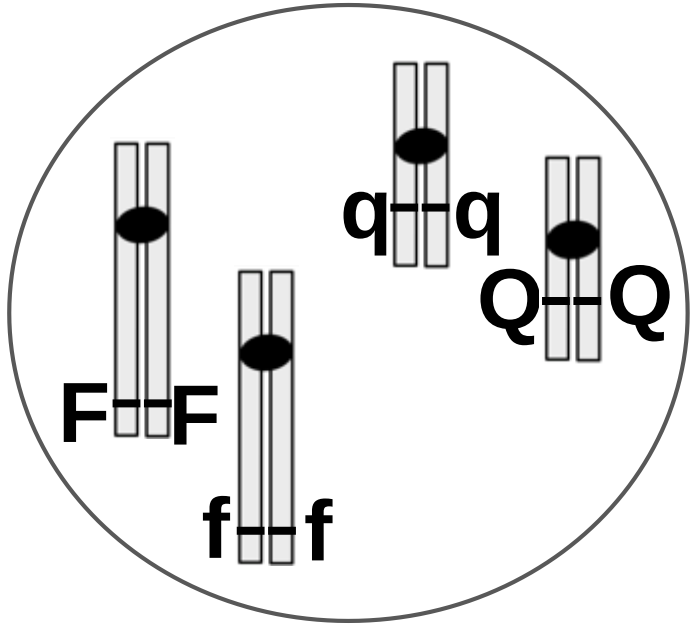
If this cell divided normally to produce sperm, what are the possible sperm genotypes?



A. F, f, Q, q
B. FQ, fq, Fq, fQ
C. Ff, Ff, Qq, Qq
D. Ff, Qq, FQ, fq, Fq, fQ

Answer

If this cell divided normally to produce sperm, what are the possible sperm genotypes?

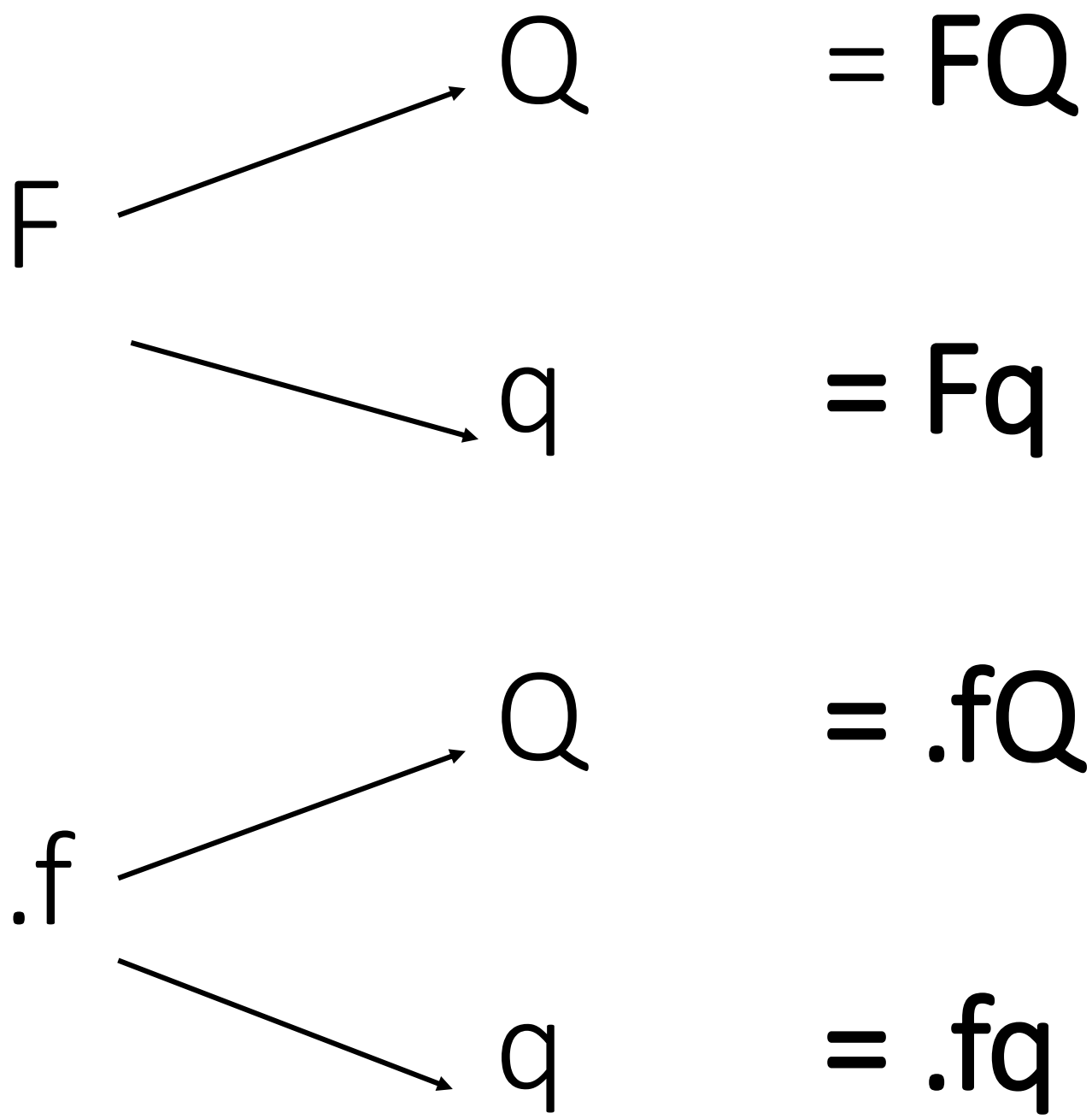


A. F, f, Q, q

B. FQ, fq, Fq, fQ

C. Ff, Ff, Qq, Qq

D. Ff, Qq, FQ, fq, Fq, fQ



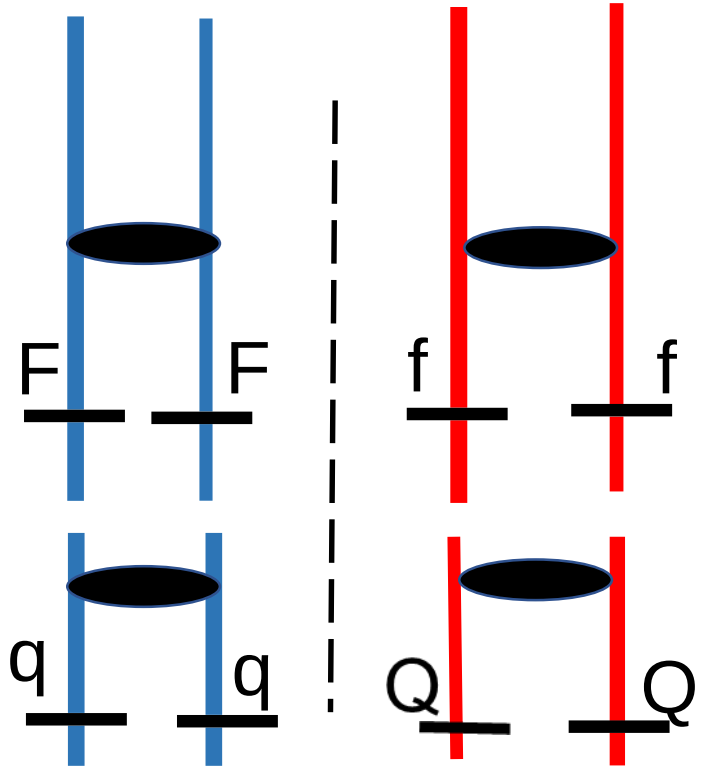
Because of the independent assortment of homologous chromosomes at Metaphase I.

The replicated homology carrying the F allele may align on the same side of the metaphase plate as the chromosome carrying the Q allele or the q allele, right?

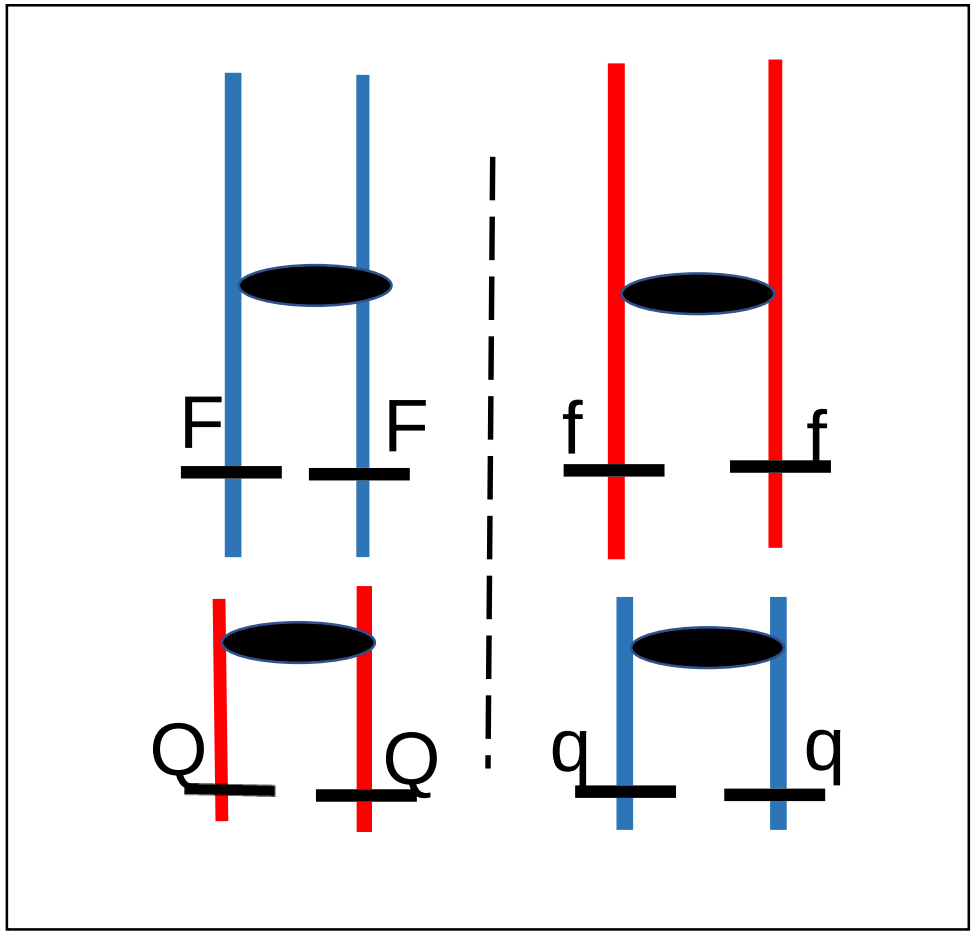
Ditto for the f allele.

Metaphase I

Independent Assortment of Homologs – 2 orientations

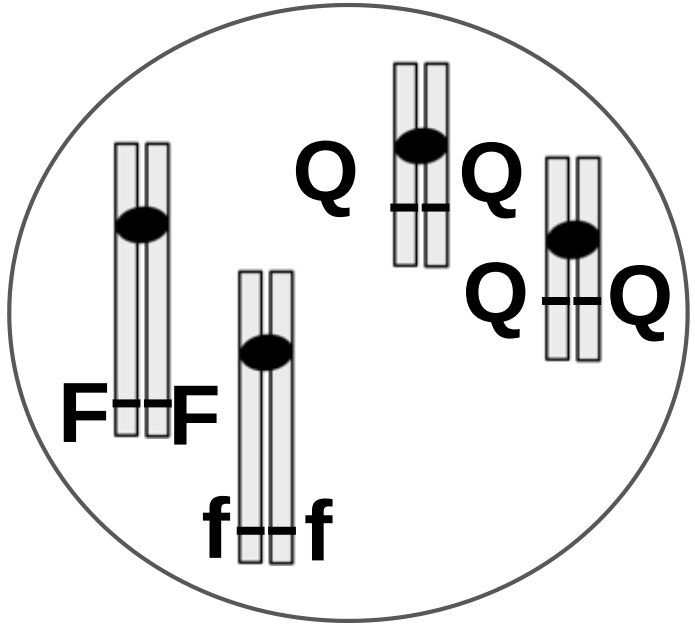


OR



iClicker Question

During meiosis, the independent assortment of homologous chromosomes at Metaphase I would _____ the gamete genotypes that would be produced.



A. Increase

B. Decrease

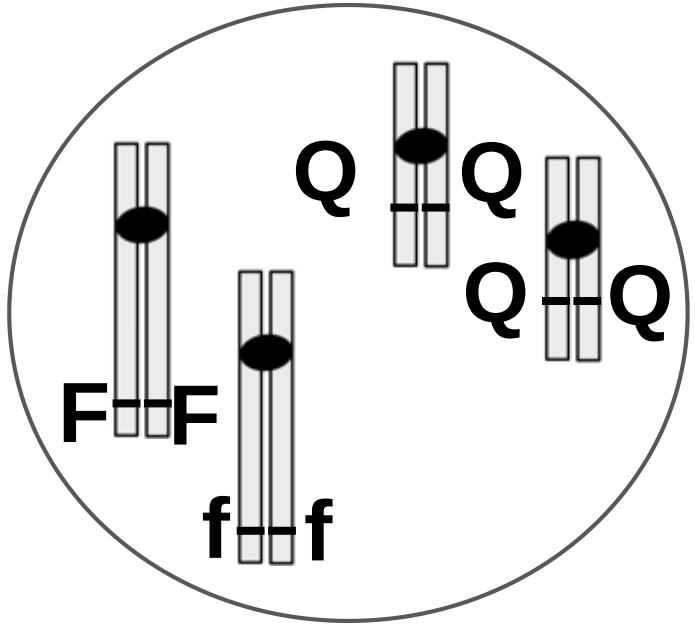
C. Not affect

D. Not sure

Note – this question has been reworded to reflect my original intent.

Answer

During meiosis, the independent assortment of homologous chromosomes shown in the cell below would _____ the gamete genotypes that would be produced.



A. Increase

B. Decrease

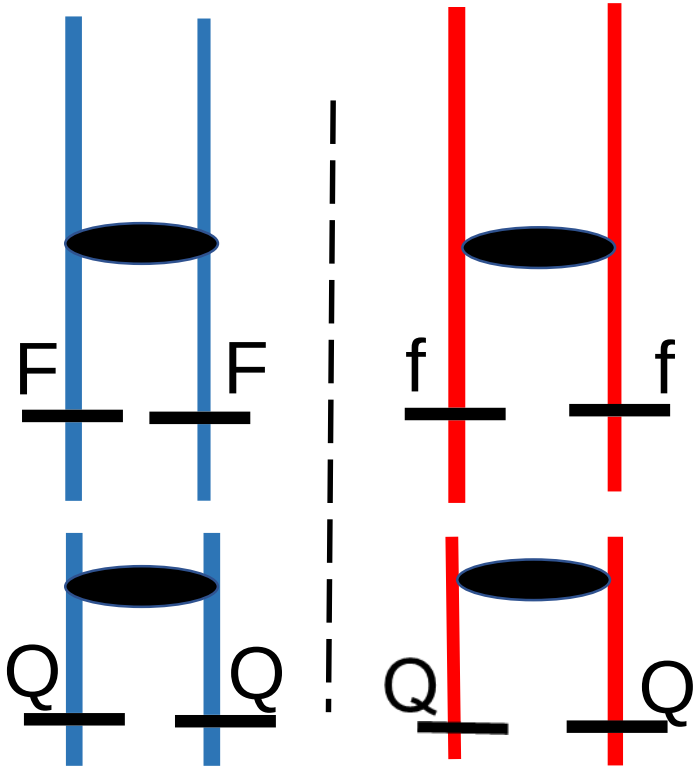
C. Not affect

D. Not sure

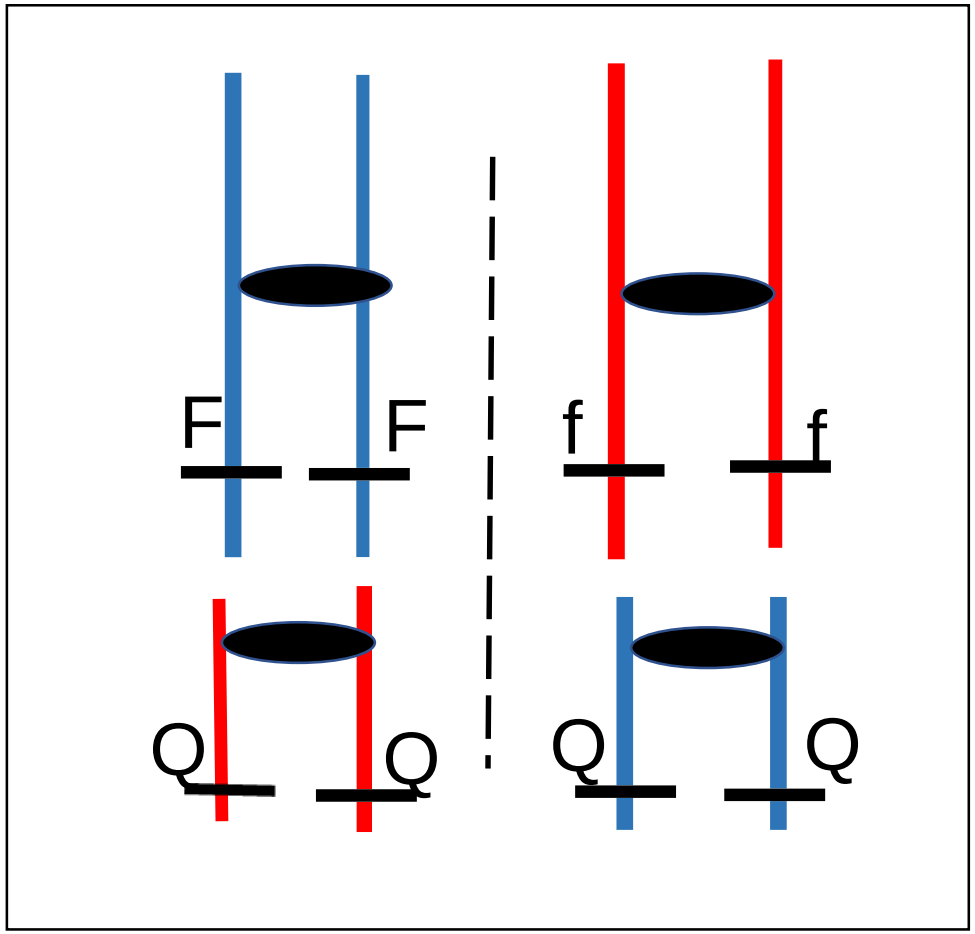
Regardless of how the homologous assorted at the metaphase plate (e.g. if all maternal chromosomes were on one side and paternal on the other; or if there was a maternal and paternal chromosome on each side), the only gamete genotypes that could be produced are FQ and fQ

Metaphase I

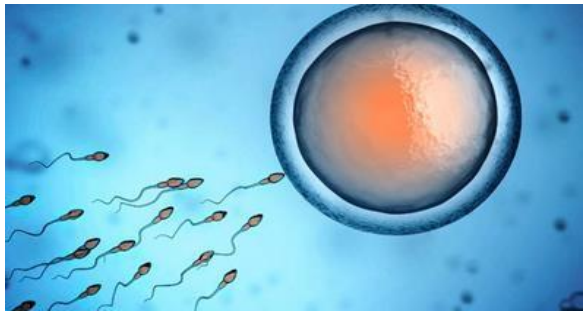
Independent Assortment of Homologs – 2 orientations



OR



3rd source of genetic variation (amongst individuals): Random fusion of eggs & sperm (testable)



Source of picture: http://www.biotechniques.com/news/How-the-Sperm-Embraces-the-Egg/biotechniques-365009.html#.Wb25GciGOUk

- Fertilization occurs when a male and female gamete fuse to form a zygote.
- It is a random event, meaning which sperm fertilizes which egg is a matter of chance.
- Each human parent has the potential to produce >8 million genetically unique gametes thanks to the independent assortment of homologous chromosomes. This does not take into consideration effects of crossing-over.
- Two parents can potentially create >64 trillion genetically distinct offspring (>8,000,000 x >8,000,000)!!!

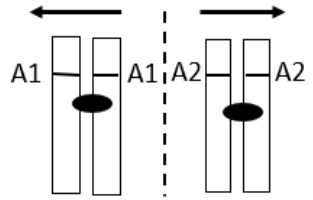
New term – segregation (not testable for my sections)

- Segregation = separation. Genetics = segregation of alleles.

- According to Dr. Brett Couch (121 Instructor)

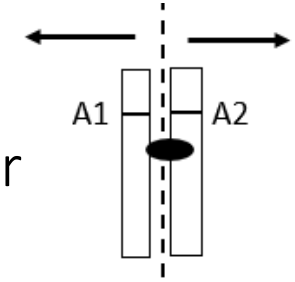
- segregation refers to the separation of <u>different</u> alleles from each other, e.g. A1 from A2 allele.

A. If the genotype was heterozygous (e.g. A1/A2); and



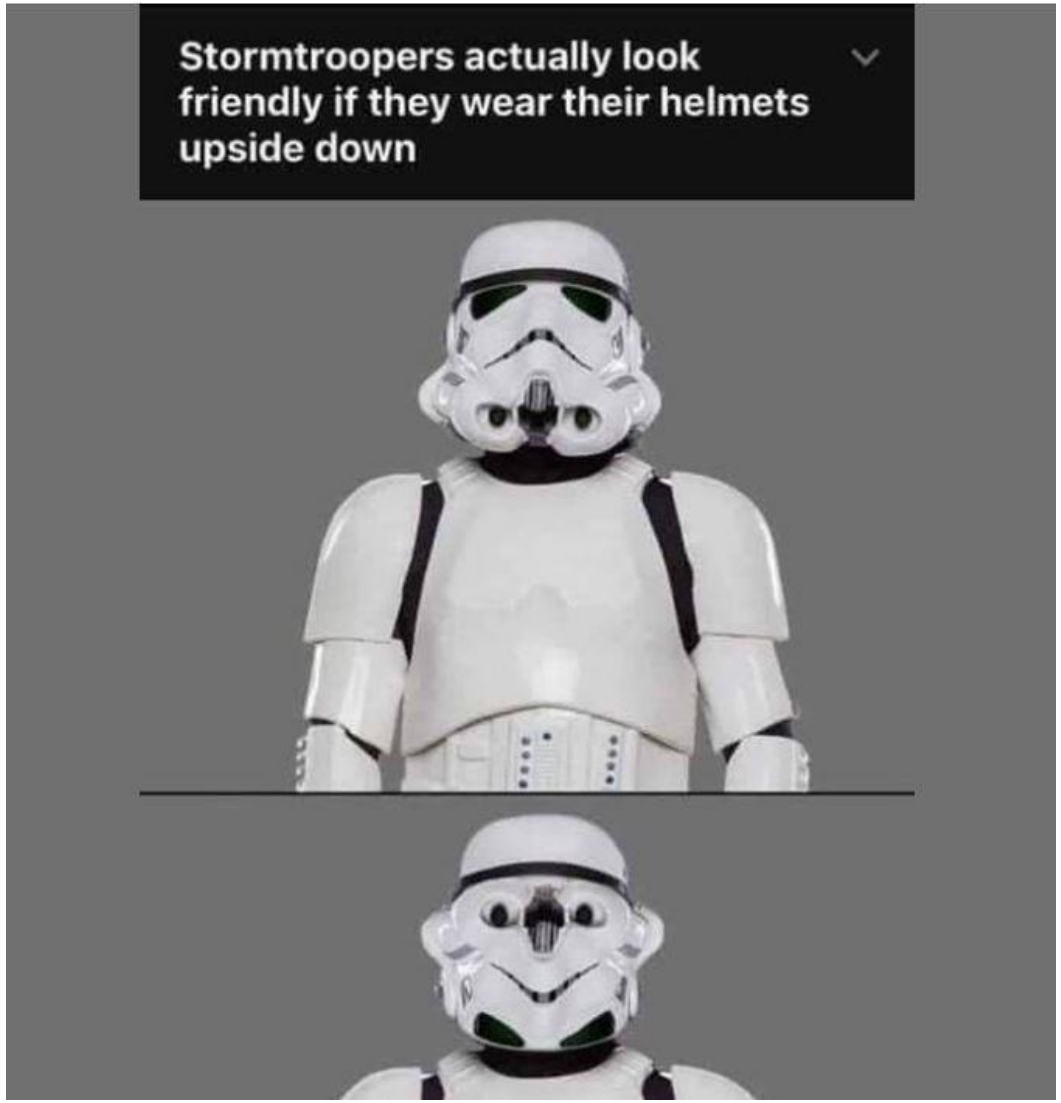
- if crossing-over/recombination did not occur (so sister chromatids are still carry the same alleles)
- then segregation of the A1 and A2 alleles would occur in Anaphase 1 (i.e. this is when the A1 and A2 alleles would be separated from each other)

B. However, if crossing-over/recombination did occur (so sister chromatids carried different alleles) then segregation of these different alleles (A1 and A2) would occur in Anaphase II (when the sister chromatids separate)



- *I am bring this up because Dr. Brett Couch kindly shares some of his worksheets, and this term may appear.*

4-minute break



Modes of Inheritance

How are traits passed from one generation to the next?

We will learn about 5 modes of inheritance (there are others):

1. Autosomal dominant
2. Autosomal recessive
3. X-linked dominant
4. X-linked recessive
5. Non-dominance

What is a trait?

- A **trait** (or character) is any observable characteristic of an organism
  - At any level: molecular, developmental, physiological, morphological, behavioural

Rough-skinned newts have many observable traits:

- Skin colour
- Skin roughness
- Body length
- Sex
- Heart beat rate

What is a phenotype?

- A **phenotype** is the state of the trait
  - e.g. red vs blue or 12.1 cm vs 9.4 cm

Tetrodotoxin

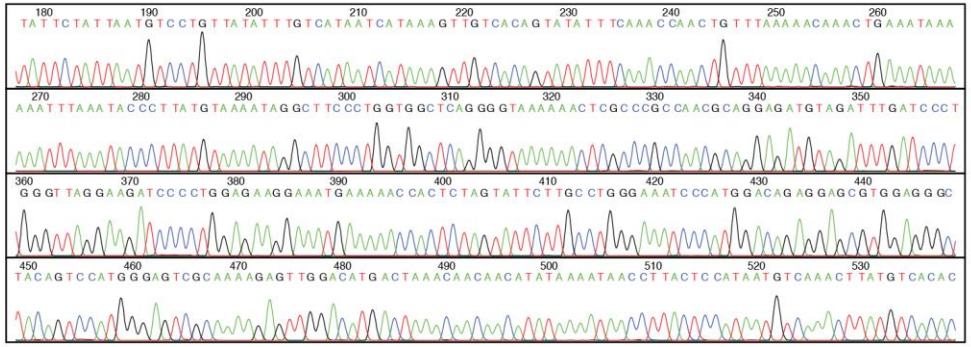
This particular rough-skinned newt has the following phenotypes:

- Eye colour: **golden**
- Skin roughness: **rough**
- Body length: **short**
- Poisonous: **YES, VERY!!!!!!**

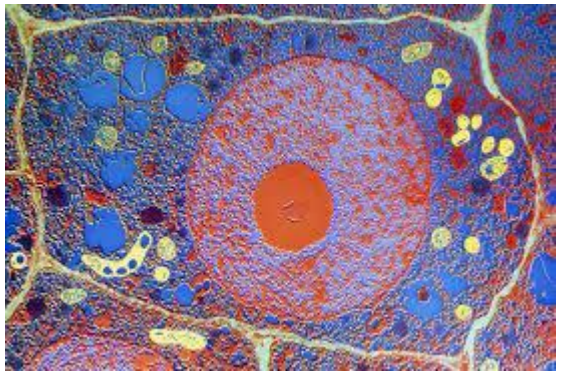
Reminder: An individual's phenotype is determined by….

The interaction between:

Genotype & **Environment**



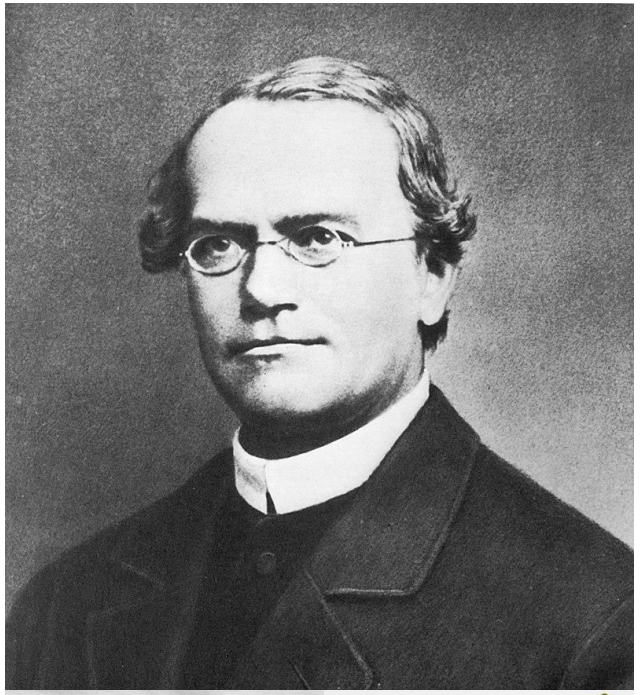
DNA sequence data from an automated sequencing machine



Chance may also play a role.

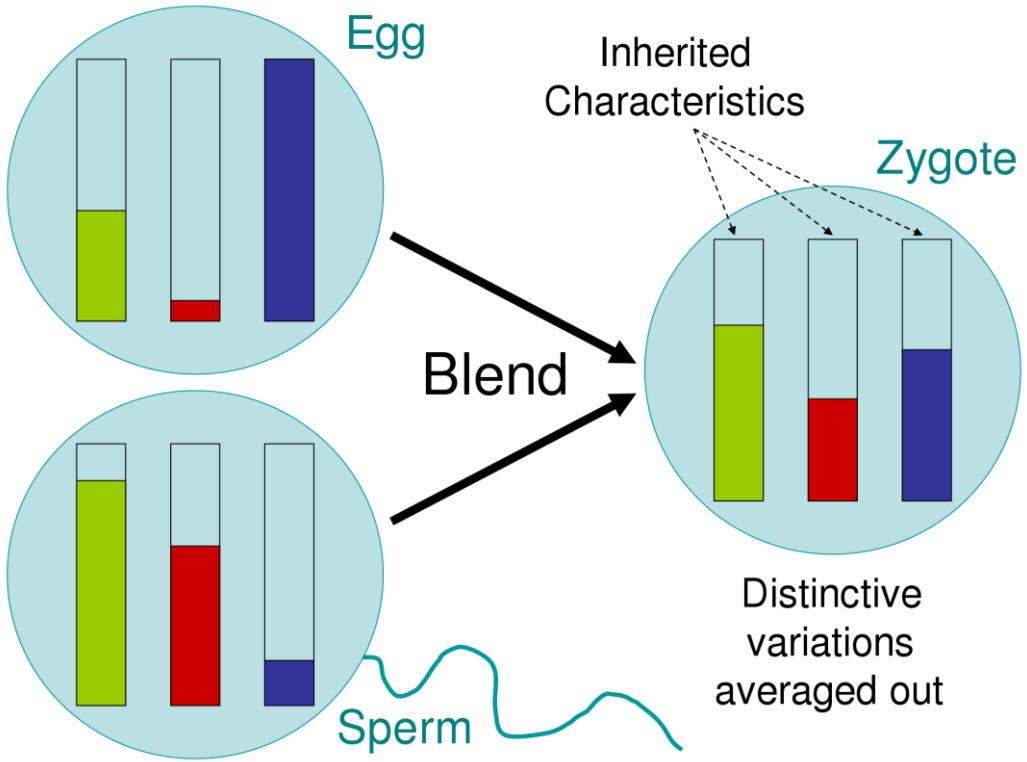
Rules of heritability were discovered by Gregor Johann Mendel

- Scientist and Augustinian friar (b. 1822 – d. 1884)
- Contemporary of Charles Darwin* (but never met)
- Known as the “father of modern genetics”
  - Documented patterns of genetic inheritance before the discovery of genes, chromosomes, DNA, meiosis…
- Fun fact: he started studying by mice, but it was inappropriate for a friar to study animal sex, so he switched to peas



** We will learn more about Darwin in the evolution unit!*

Before Mendel's discoveries…



- Farmers had known for thousands of years that you can produce desirable phenotypes in offspring by selective breeding
- Scientists thought phenotypes were inherited through "**blending inheritance**" (see left)*
  - e.g., if a black cat mates with a white cat, the offspring should all be shades of grey

**Note: this pattern can occur, but scientist's proposed mechanism for why it happens was wrong.*

Why did Mendel study peas (*Pisum*)?

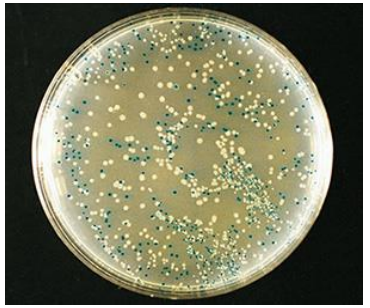
- Easy to maintain
- Grow and reproduce quickly
- Easily identifiable traits/phenotypes
- Easy to cross (purposefully mate) parents
- Fewer ethical concerns

These are all key traits of model organisms! Other model organisms:

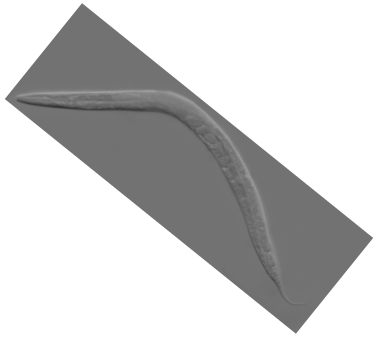
Arabidopsis thaliana (rockcress)

Mus musculus (mouse)

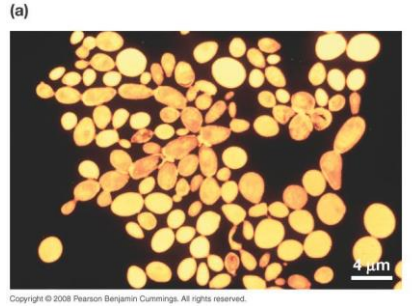
Drosophila melanogaster (fruit fly)



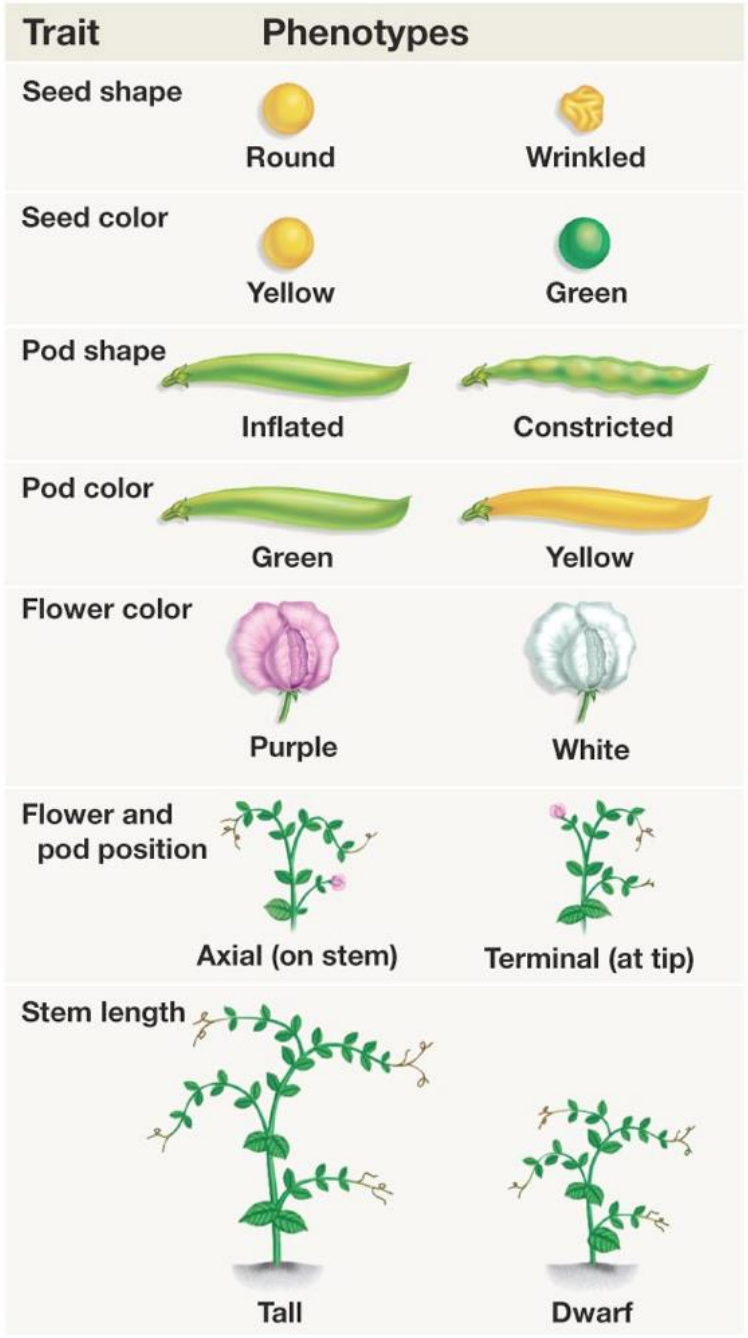
Escherichia coli (bacteria)



Caenorhabditis elegans (nematode)



Saccharomyces cerevisiae (yeast)



Mendel studied the inheritance patterns of 7 traits

What he couldn't know at the time:

- Each trait only had two possible phenotypes (e.g., yellow or green, tall or short)
- Each trait was determined by 1 gene with only 2 alleles
- One allele was dominant over the other allele
- The genes were on separate chromosomes (not physically linked)
- The traits were autosomal (not X-linked)

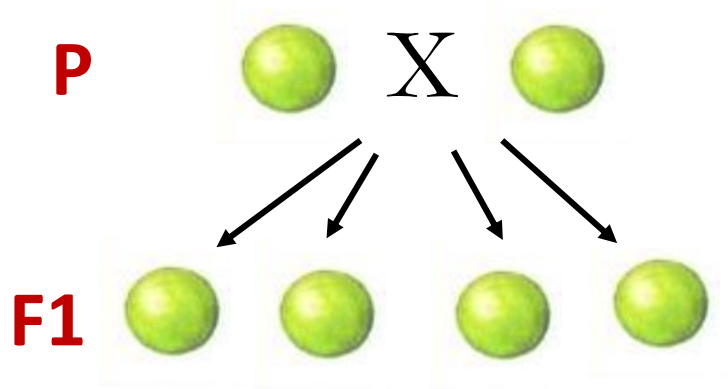
Mendel started with "true-breeding"* parents with same phenotypes

What does true-breeding (or pure-breeding) mean?

Answer: when he mated a **round-seeded** parent (P) with **another round-seeded parent**, all offspring (F1)** produced round seeds.

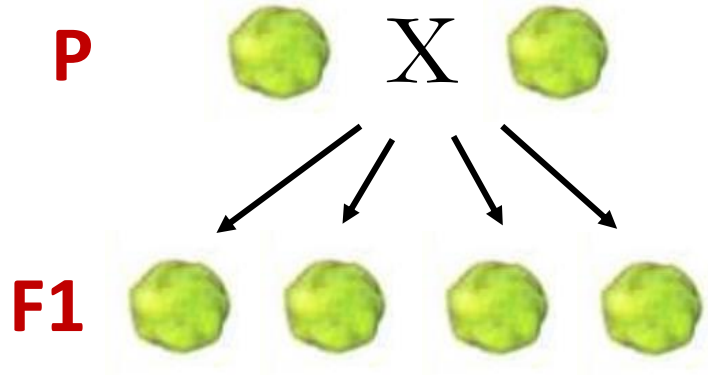
** "F" = filial generation

round seed X round seed



Similarly, if 2 parents (P) have **wrinkled seeds**, all their offspring (F1) also produced wrinkled seeds.

wrinkled seed X wrinkled seed

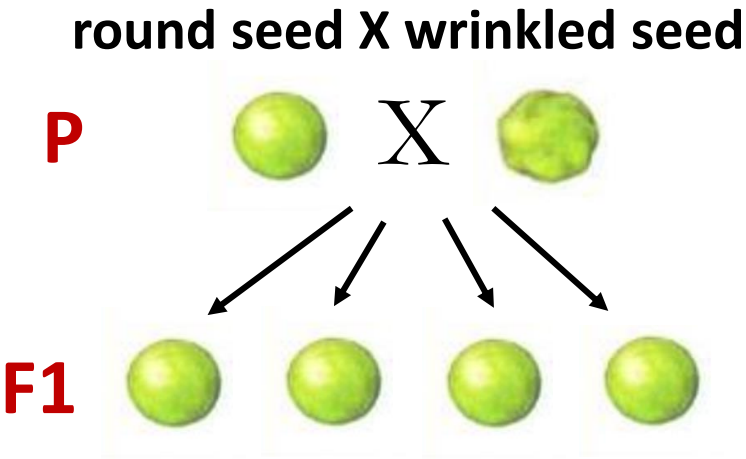


* a.k.a. pure-breeding

Mendel then crossed true-breeding parents (P generation) with different phenotypes (round and wrinkled) to produce F1 generation

Mendel crossed a true-breeding **round-seeded** parent with a true-breeding **wrinkled-seeded parent**

- the offspring produced (F1s) **only had round seeds** (the wrinkled phenotype disappeared!)



From this cross, Mendel was able to conclude that:

- Blended inheritance cannot be correct (or all seeds would be a little bit wrinkled).
- Round seeds are dominant to wrinkled seeds (i.e. wrinkled phenotype disappeared in F1s)

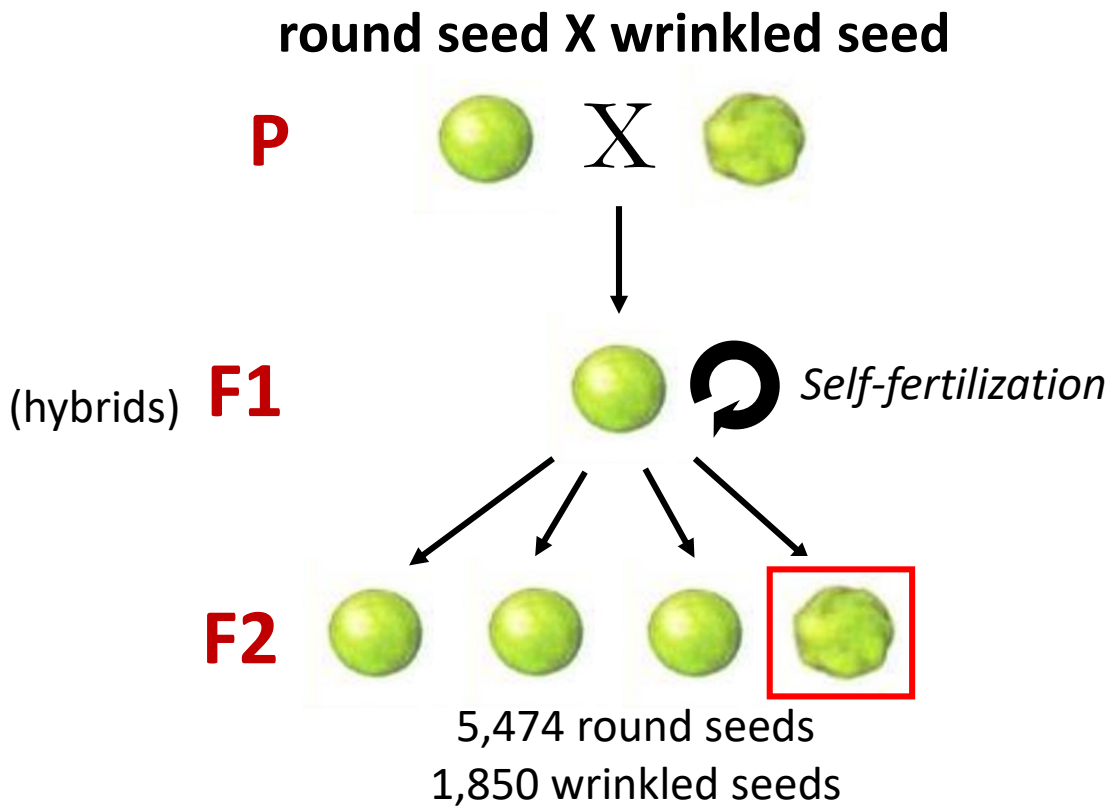
Mendel then allowed the F1 hybrids to self-pollinate

When the **F1 hybrid** were allowed to self-pollinate the wrinkled seeds reappeared!

The F1 cross produced offspring (**F2**) that had **75% round-seeds** and **25% wrinkle-seeds**!

There was a **phenotypic ratio** of ~3:1 round:wrinkled.

I recommend knowing this phenotypic ratio – it will become important when we get to using genetic crosses to determine mode of inheritance



What we now know

Mendel's true-breeding parents were **homozygous** for the seed shape gene

- The true-breeding plants with round seeds have 2 copies of the dominant allele (R)
  - **Genotype = RR**
- The true-breeding plants with wrinkled seeds have 2 copies of the recessive allele (r)
  - **Genotype = rr**

round seed X wrinkled seed

Standard notation:

- Uppercase letters are for dominant alleles, lowercase letters are for recessive alleles
- "R" comes from the phenotype associated with the dominant allele (round).

The terms dominant and recessive refers to relationships between specific alleles

Dominant allele: determines the phenotype of a heterozygous (**Rr**) and homozygous dominant (**RR**) individual

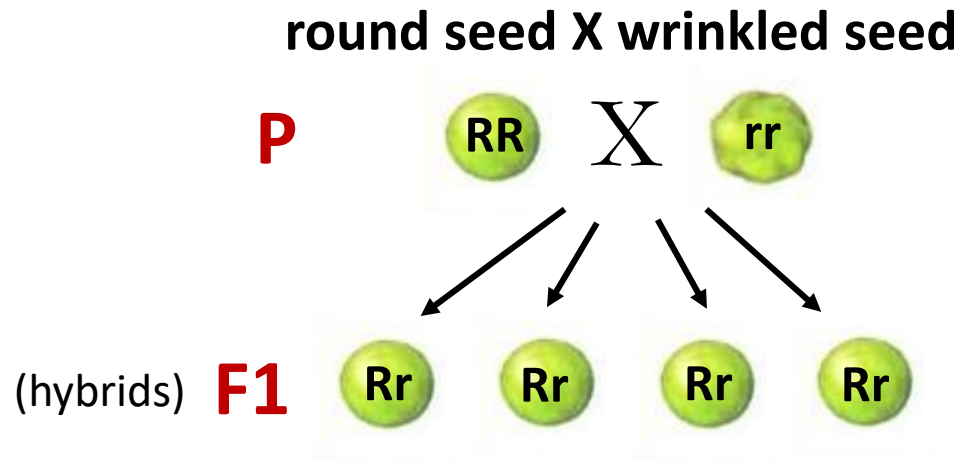
- Typically codes for a functional protein

Recessive allele: phenotype is observed only in homozygous recessive individuals (**rr**)

- Typically codes for proteins that are non-functional or have reduced function

* An F1 hybrid generation tells you the relationship between alleles

(but does not tell you if the gene is on an autosome or chromosome – to be discussed next class)



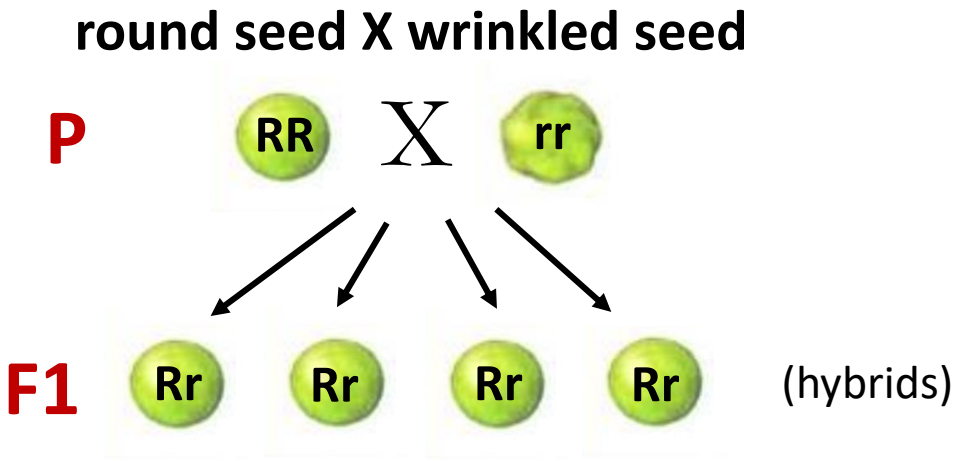
We also now know that:

Mendel's hybrid offspring (F1s) are **heterozygous** for the seed shape gene (or they are hybrids*).

- F1 genotype = Rr

- They inherited the allele for round shape (R) from one parent and the allele for wrinkled shape (r) from the other parent.

- Even though the F1 seeds were carrying alleles for both shapes (Rr), all F1s were round, indicating that the allele for round shape is dominant to the allele for wrinkled shape.*



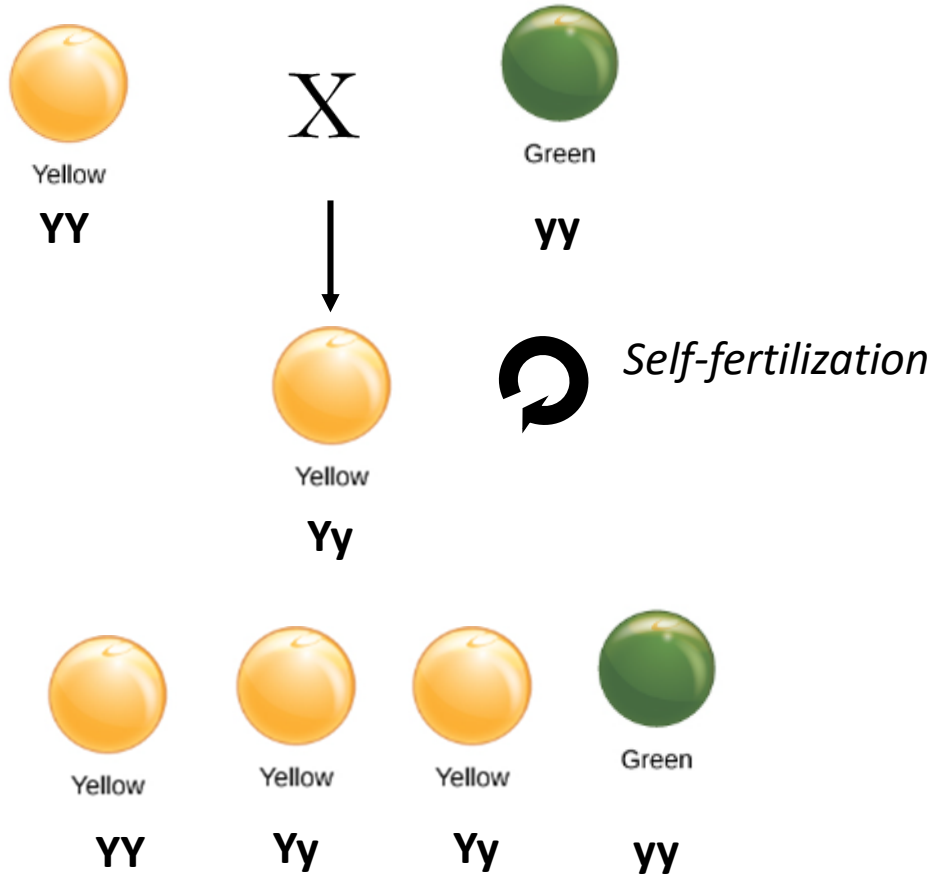
*A hybrid organism is an organism that is heterozygous, which means that it carries two different alleles at a particular genetic position, or locus.

In diploid organisms, heterozygous individuals (a.k.a. heterozygotes) carry <u>different</u> alleles

Mendel repeated his experiment with other traits…

1. Started with pure-breeding parents
2. Allowed F1s to self-pollinate
3. Calculated F2 phenotypic ratio

Yellow seed colour x Green seed colour



6022 yellow seeds
2001 green seeds

~ 3:1 ratio

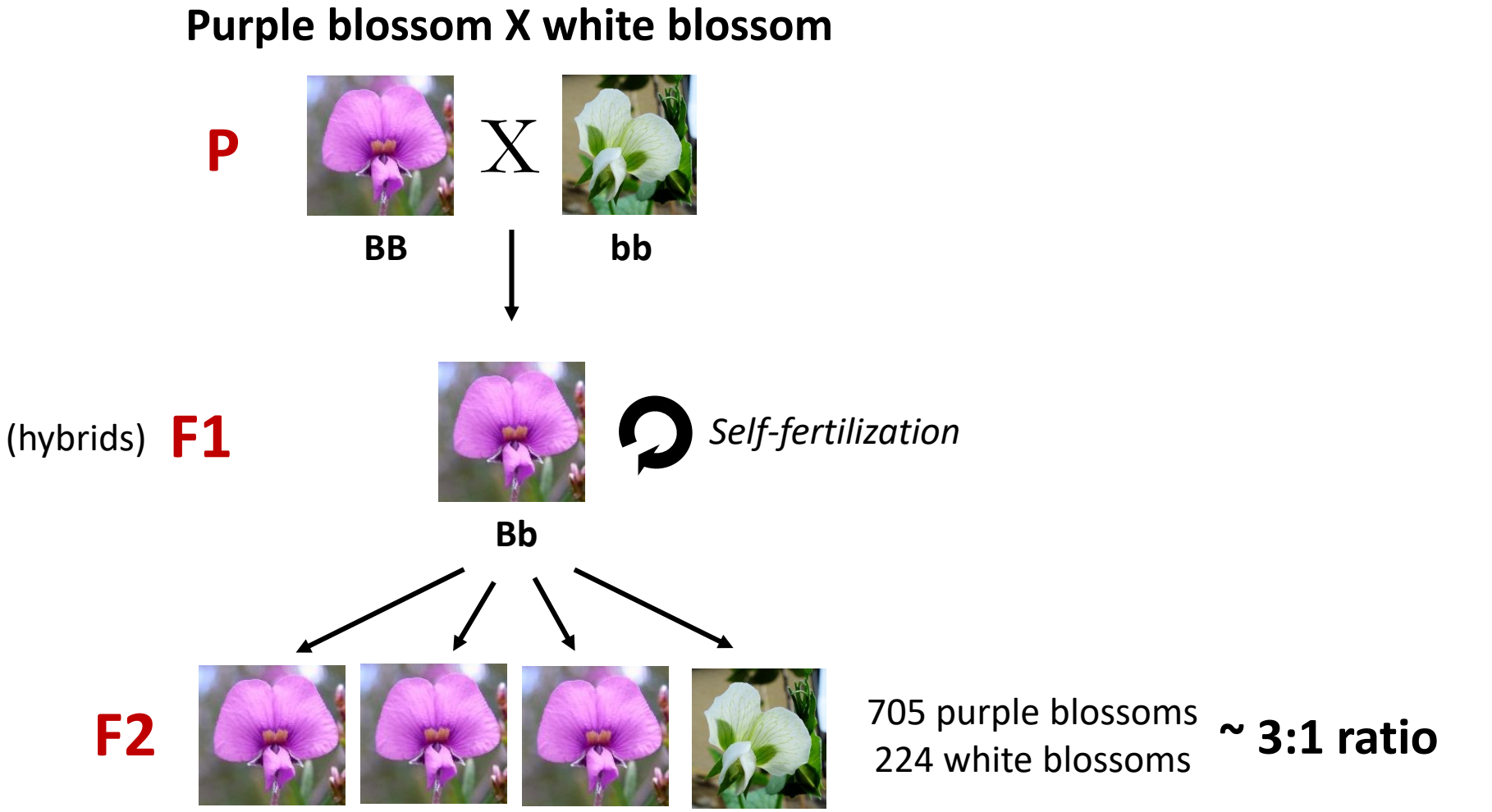
https://bio.libretexts.org/

Flower colour

1. Started with pure-breeding parents

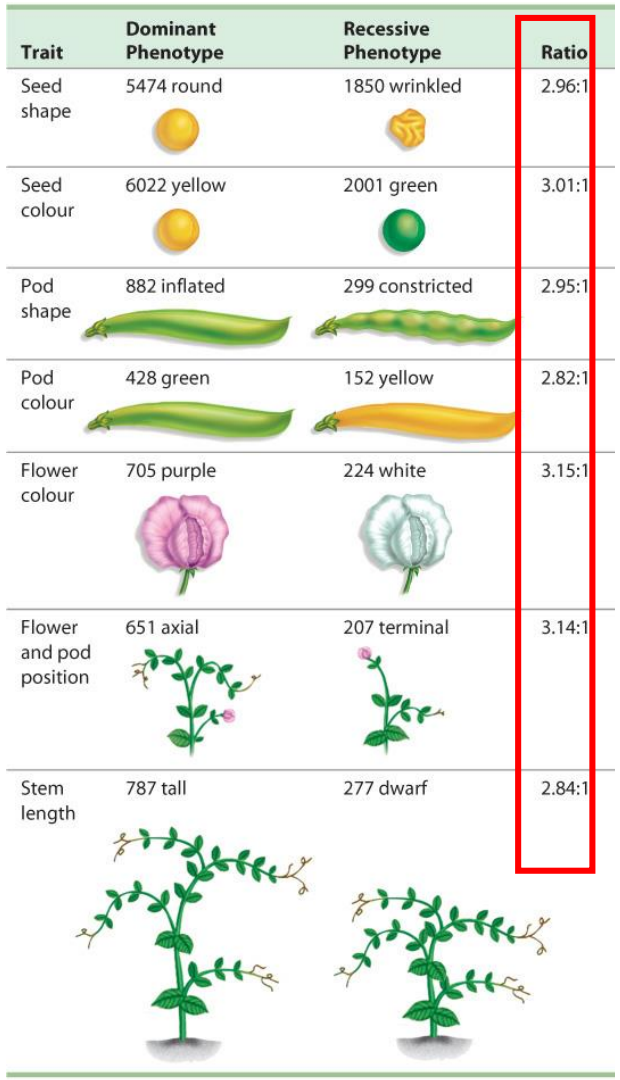
2. Allowed F1s to self-pollinate

3. Calculated F2 phenotypic ratio



Mendel found the same 3:1 phenotypic ratio in the F2 generation for all 7 traits

Trait	Dominant Phenotype	Recessive Phenotype	Ratio
Seed shape	5474 round	1850 wrinkled	2.96:1
Seed colour	6022 yellow	2001 green	3.01:1
Pod shape	882 inflated	299 constricted	2.95:1
Pod colour	428 green	152 yellow	2.82:1
Flower colour	705 purple	224 white	3.15:1
Flower and pod position	651 axial	207 terminal	3.14:1
Stem length	787 tall	277 dwarf	2.84:1



Note: these experiments were **monohybrid crosses** (parents only differ in alleles at one locus of interest)

Mendel also performed **reciprocal crosses** to see if sex of the parent affects the outcome

♂ ♀

BB

X

bb

→ 3:1 ratio in F2

♂ ♀

BB

X

bb

→ 3:1 ratio in F2

- Reciprocal cross = phenotypes of male and female are reversed in different crosses
- Same outcome (3:1 ratio) regardless of whether alleles come from male or female parent*
- So sex is not important, indicating that the gene is on autosome not an X-chromosome.

* This is not true for X-linked traits, to be discussed on Thursday.

Observed phenotype ratio = predicted phenotype ratio

♂ ♀


BB

X


bb

→ 3:1 ratio in F2

♂ ♀


BB

X


bb

→ 3:1 ratio in F2

The observed 3:1 phenotypic ratio is what we would predict to see for a cross between:

- Two heterozygotes
- One gene, two alleles
- Dominant, recessive relationship
- Gene on an autosome

* This is not true for X-linked traits, to be discussed on Thursday.

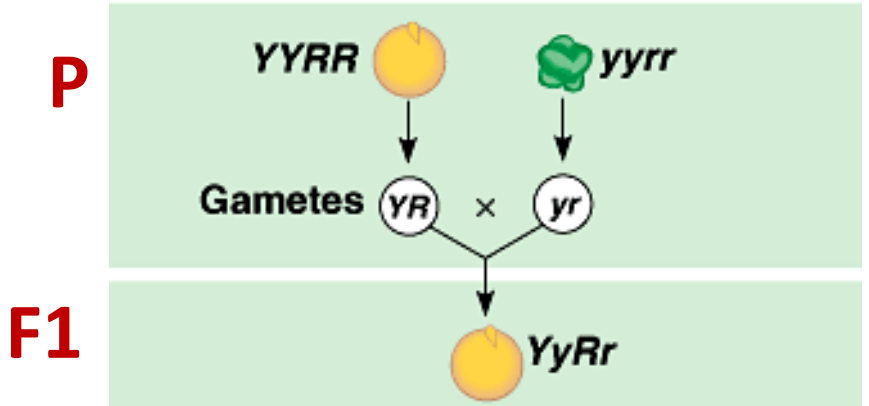
Mendel: **Two traits**

Mendel wanted to test what happened when he crossed peas that were heterozygous for **two traits***.

Traits of choice:

- Seed colour
  - Yellow (Y) is dominant to green (y)
- Seed shape
  - Round (R) is dominant to wrinkled (r)

Step 1: Mendel created a **dihybrid** F1 generation by crossing true-breeding parents:



All the F1 offspring have yellow, round seeds

* These genes are **unlinked** (on separate chromosomes).

Mendel then crossed his F1s (**YyRr x YyRr**), i.e. did a dihybrid cross*, to produce an F2 generation

Mendel <u>observed</u> the following phenotypes in his crosses:

Parents: **round seeds, yellow seeds X wrinkled seeds, green seeds**

F1: all round and yellow seeds

		Number	Fraction
F2:	round, yellow	315	9/16
	round, green	108	3/16
	wrinkled, yellow	101	3/16
	wirnkled, green	32	1/16

So, Mendel observed a 9:3:3:1 phenotypic ratio (when considering both traits together).

Or, a 3:1 phenotypic ratio if you separate each trait.

Yellow:green = 416: 140 or ~ 3:1

Round:wrinkled = 415:133 or ~ 3:1

This is the outcome we would expect for a cross between:

- 2 heterozygotes
- Autosomal genes, not linked
- Dominant/recessive relationship between alleles

*A dihybrid cross describes **a mating experiment between two organisms that are identically hybrid for two traits**

Predicting offspring genotypes and phenotypes when the pattern of inheritance is known (or hypothesized)

- Punnett Square
- Invented by Reginald Punnett, a geneticist (1875-1967)

Gametes from one parent, e.g. A/a

Gametes from the other parent, e.g. A/a

	A	a
A	Genotype of possible offspring AA	Genotype of possible offspring Aa
a	Genotype of possible offspring Aa	Genotype of possible offspring aa

Assumes random fusion of eggs and sperm

BIOL 121-221 – we stopped here

Predicted F1 genotypes and phenotypes

- If mode of inheritance for flower colour is **autosomal** with the allele for purple flower colour **dominant** to the allele for **recessive** flower colour…
- If you cross true-breeding parents, the predicted F1 offspring genotype and phenotype would be……

Purple blossom X white blossom

P  X 

BB | bb

♂

P Parent 1 (B/B)

Gametes

B

♀

P Parent 2 (b/b)

b

Bb

all F1s will have the genotype Bb and purple flowers

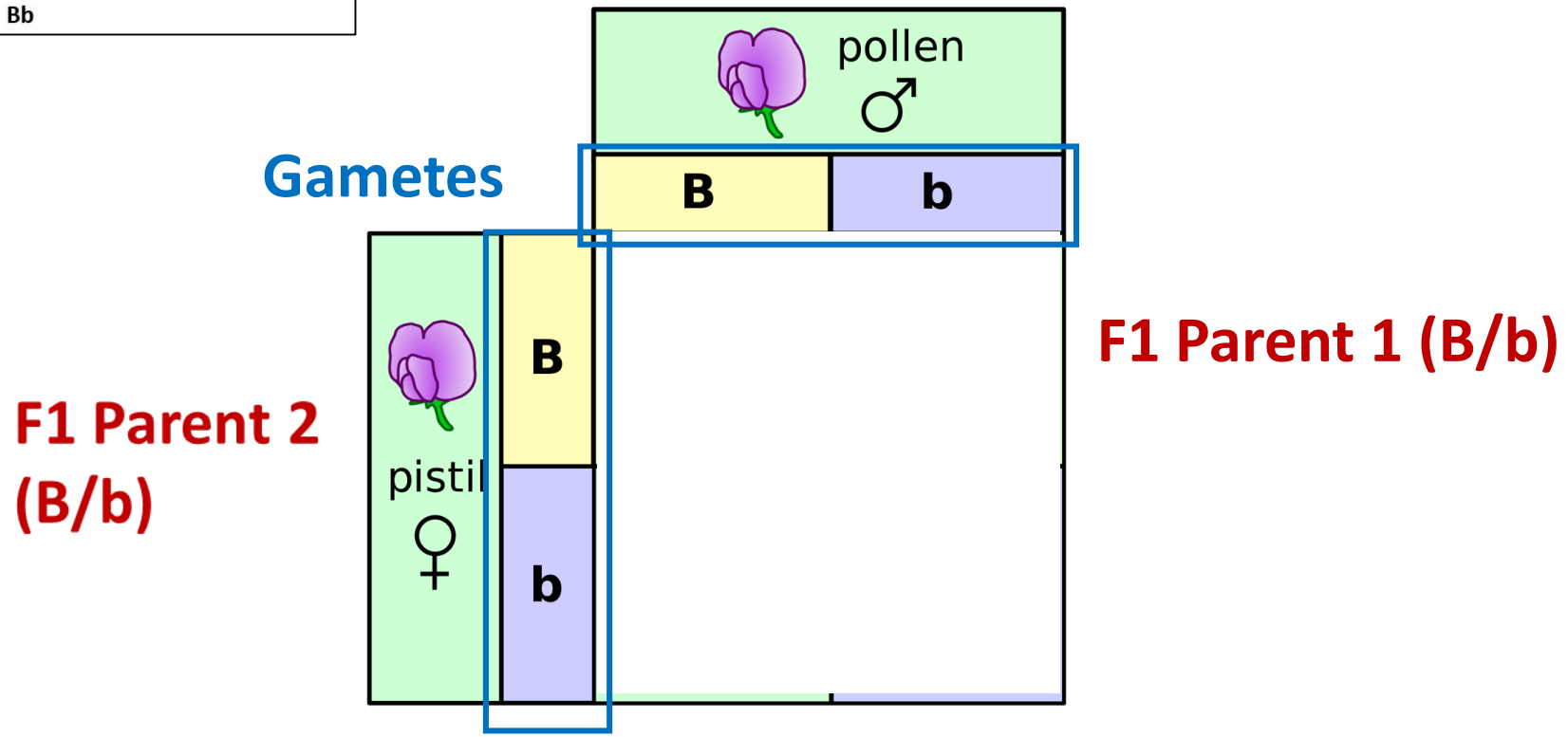
Source: Madprime, Wikimedia Commons

Predictions for the F2 genotypes and phenotypes, if you crossed two F1s

(hybrids) **F1**

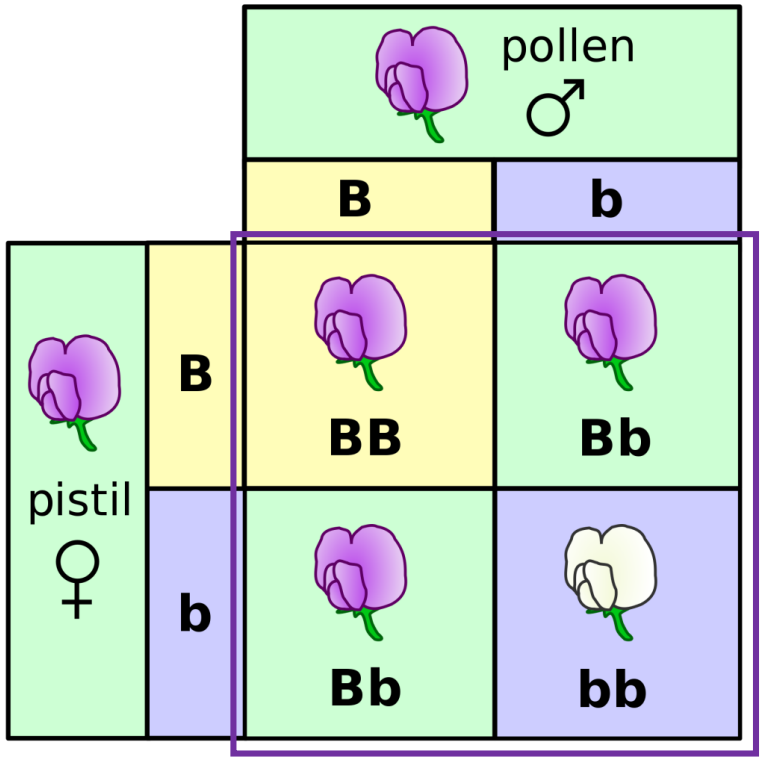
Bb

Self-fertilization



Source: Madprime, Wikimedia Commons

Predicting F2 genotypes and phenotypes of offspring with a Punnett square



If random fusion of eggs and sperm –

predicted offspring (F2) genotypes and phenotypes

Source: Madprime, Wikimedia Commons

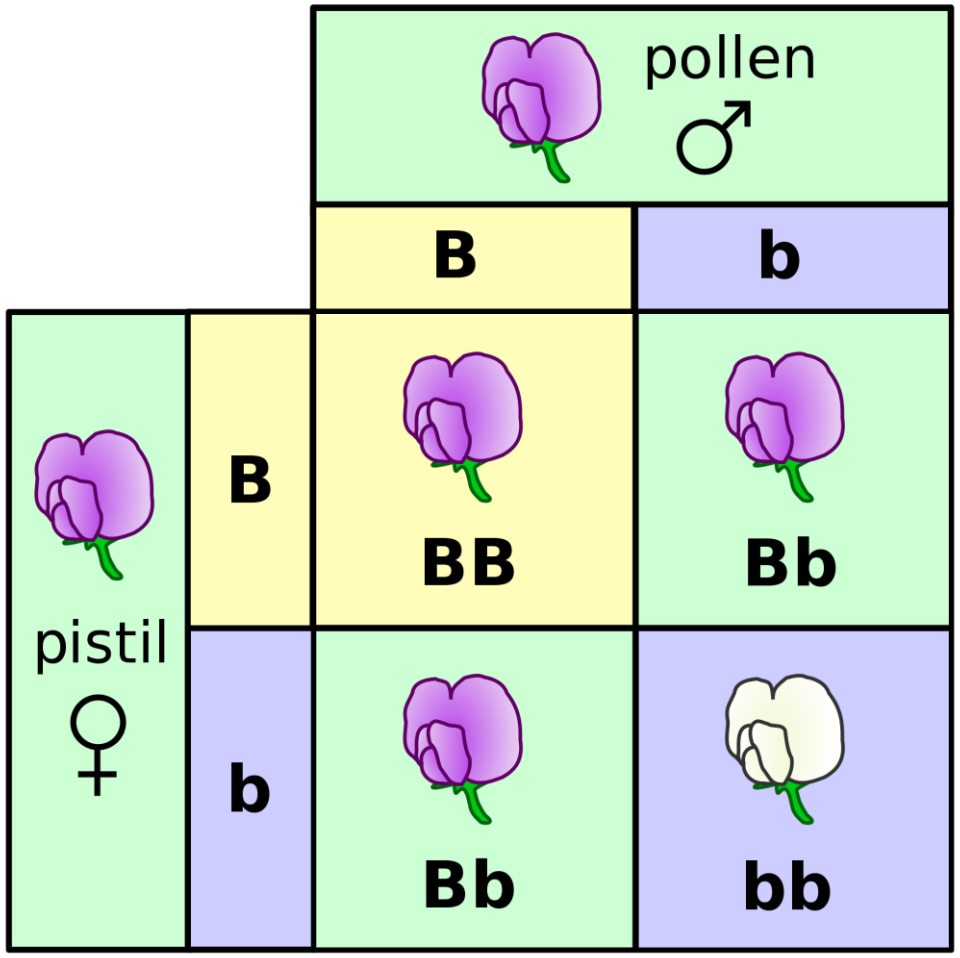
Predicting F2 genotypes and phenotypes of offspring with a Punnett square

Genotype frequency/ratio of the offspring from a cross of 2 heterozygotes:

- ¼ BB, ½ Bb, ¼ bb (1:2:1)

Phenotype frequency/ratio of the offspring from a cross of 2 heterozygotes:

- ¾ purple, ¼ white **(3:1)**



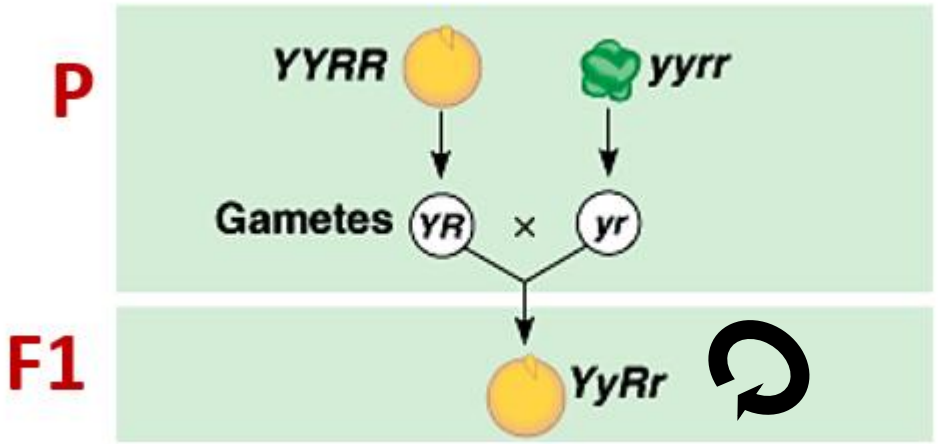
iClicker Question

Step 2. Mendel allowed the F1 to self-pollinate (**YyRr x YyRr**)?

Question:

How many gamete genotypes are possible from one **YyRr** parent? Note genes are not linked; so, can assort independently (**2^n**)

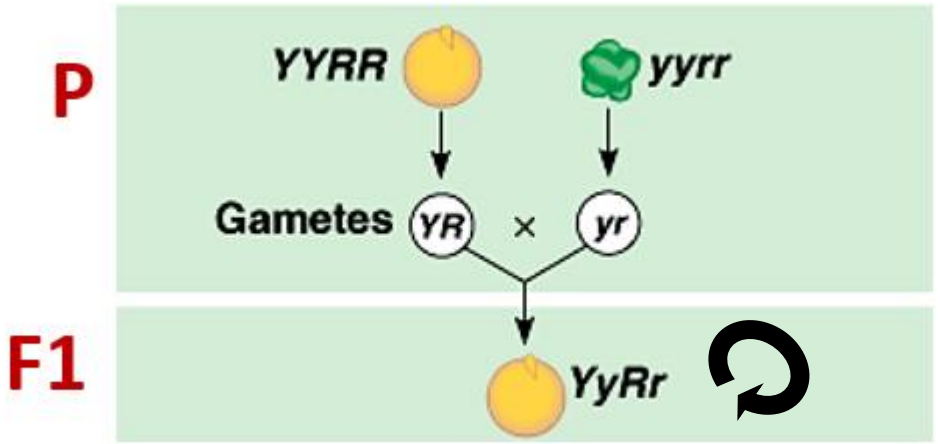
A. 2
B. 4
C. 6
D. 8
E. Unsure



Self-fertilization

Answer

Step 2. Mendel allowed the F1 to self-pollinate (**YyRr x YyRr**)?



Self-fertilization

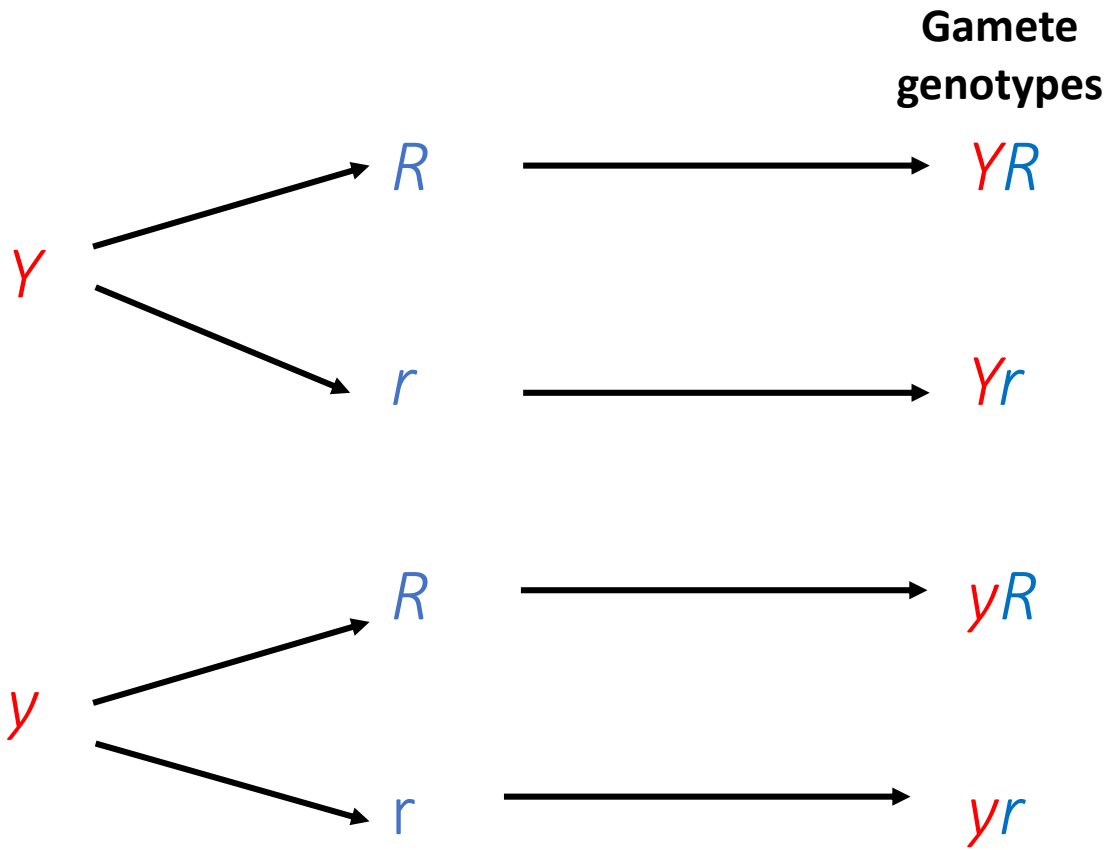
Question:

How many gamete genotypes are possible from <u>one</u> **YyRr** parent?

A. 2
B. 4
C. 6
D. 8
E. Unsure

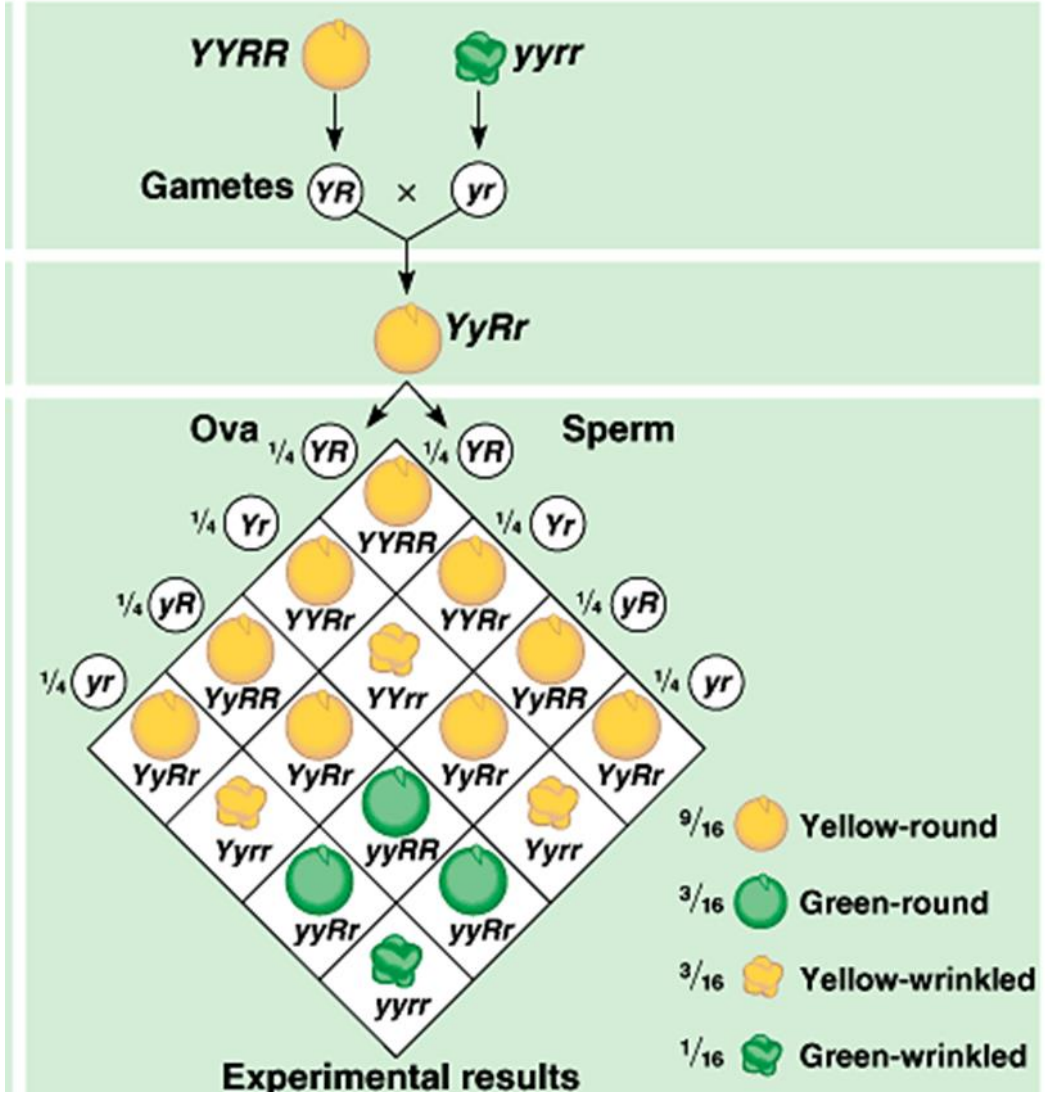
Answer – for each parent

YyRr x *YyRr*



BIOL 121-224 – we stopped here

Predicted genotypes and phenotypes - two traits (autosomal genes, not linked) – a large Punnett Square (not recommended).



Note: 3:1 ratio for each trait (seed colour and seed shape)

Predicted genotype/phenotype frequencies - alternative (recommended), create a Punnett Square for each trait (if genes not linked)

Mendel's Two Trait Experiment – F1 cross (YyRr x YyRr)

Seed Colour - Yy x Yy

	Y	.y
Y	YY	Yy
.y	Yy	.yy

Y = yellow
.y = green
R = round
.r = wrinkled

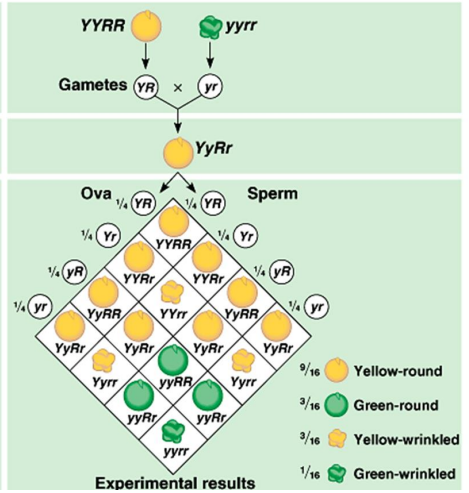
Seed Shape – Rr x Rr

	R	.r
R	RR	Rr
.r	Rr	.rr

Yellow seeds (Y_): 3 out of 4
Green seeds (yy): 1 out of 4

Round seeds (R_): 3 out of 4
Wrinkled seeds (rr): 1 out of 4

So:
predicted frequency of yellow round seeds (Y_R_) = ¾ x ¾ = 9/16
predicted frequency of green, round seeds (yyR_) = ¾ x ¼ = 3/16
predicted frequency of yellow, wrinkled seeds (Y_rr)= ¾ x ¼ = 3/16
predicted frequency of wrinkled green seeds (yyrr) = ¼ x ¼ = 1/16



What you need to know/be able to do (from today's lecture)

- Know the meaning of the terms autosomal dominant and autosomal recessive with respect to the relationship between alleles
- Know the meaning of the term true-breeding (or pure-breeding)
- Given the genotypes of the parents (<u>one</u> or two genes) and a known or hypothesize mode of inheritance for autosomal genes that are unlinked
  - predict the genotypes of their gametes (and in what frequencies or proportions)
  - predict the genotypes and phenotypes of their offspring, and in what frequencies or proportions