“Welcome to Mars”
LB144-Pandemic edition

Pop Quiz!

Test Your Knowledge

Pop Quiz!: *Jeopardy*

Your BUZZER -> Hit **Reactions** and choose “clapping hands”

Pop Quiz!: *Jeopardy* 

Alternative versions of individual genes are called ________.

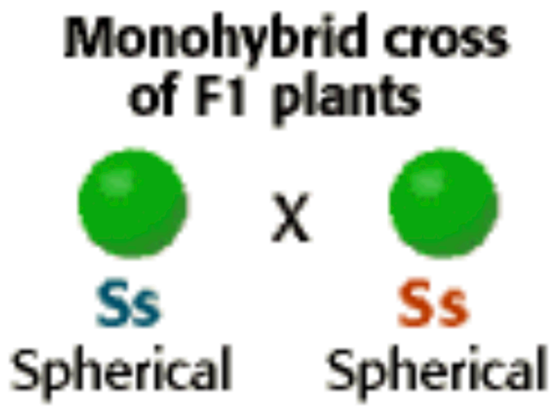
A. gametes
B. alleles
C. loci
D. homozygous

Your BUZZER -> Hit **Reactions** and choose “clapping hands”

Pop Quiz!: *Jeopardy* 

F2?: In pea plants, spherical seeds (S) are dominant to dented seeds (s). In a genetic cross of two plants that are heterozygous for the seed shape trait, what fraction of the offspring should have spherical seeds?

A. None
B. 1/4
C. 1/2
D. 3/4
E. All

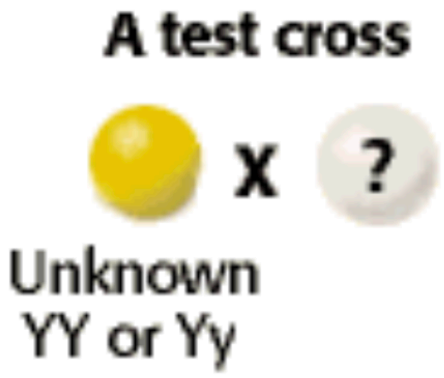


Your BUZZER -> Hit **Reactions** and choose “clapping hands”

Pop Quiz!: *Jeopardy* 

Test Cross: To identify the genotype of yellow-seeded pea plants as either homozygous dominant (YY) or heterozygous (Yy), you could do a test cross with plants of genotype _______.

A. y
B. Y
C. yy
D. YY
E. Yy



Your BUZZER -> Hit **Reactions** and choose “clapping hands”

Pop Quiz!: *Jeopardy*

A cross between a black mouse and a brown mouse produced 4 black offspring and 4 brown offspring. Black coat color is dominant to brown coat color, and therefore you can conclude that ________.

A. the black parent was homozygous
B. both parents are homozygous
C. the brown parent was heterozygous
D. the black parent was heterozygous

Your BUZZER -> Hit **Reactions** and choose “clapping hands”

Pop Quiz!: *Jeopardy* 

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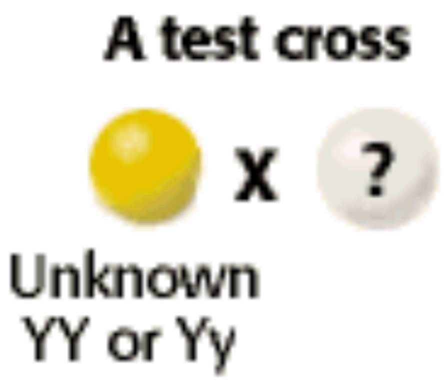

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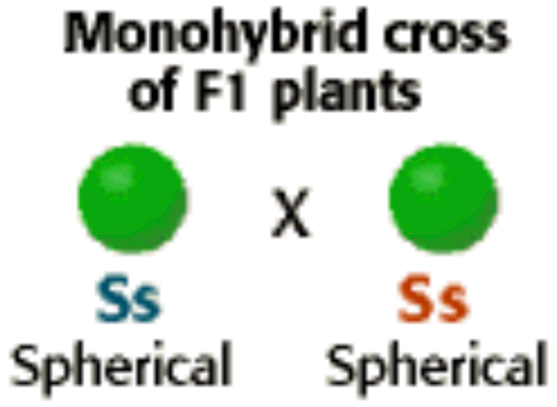

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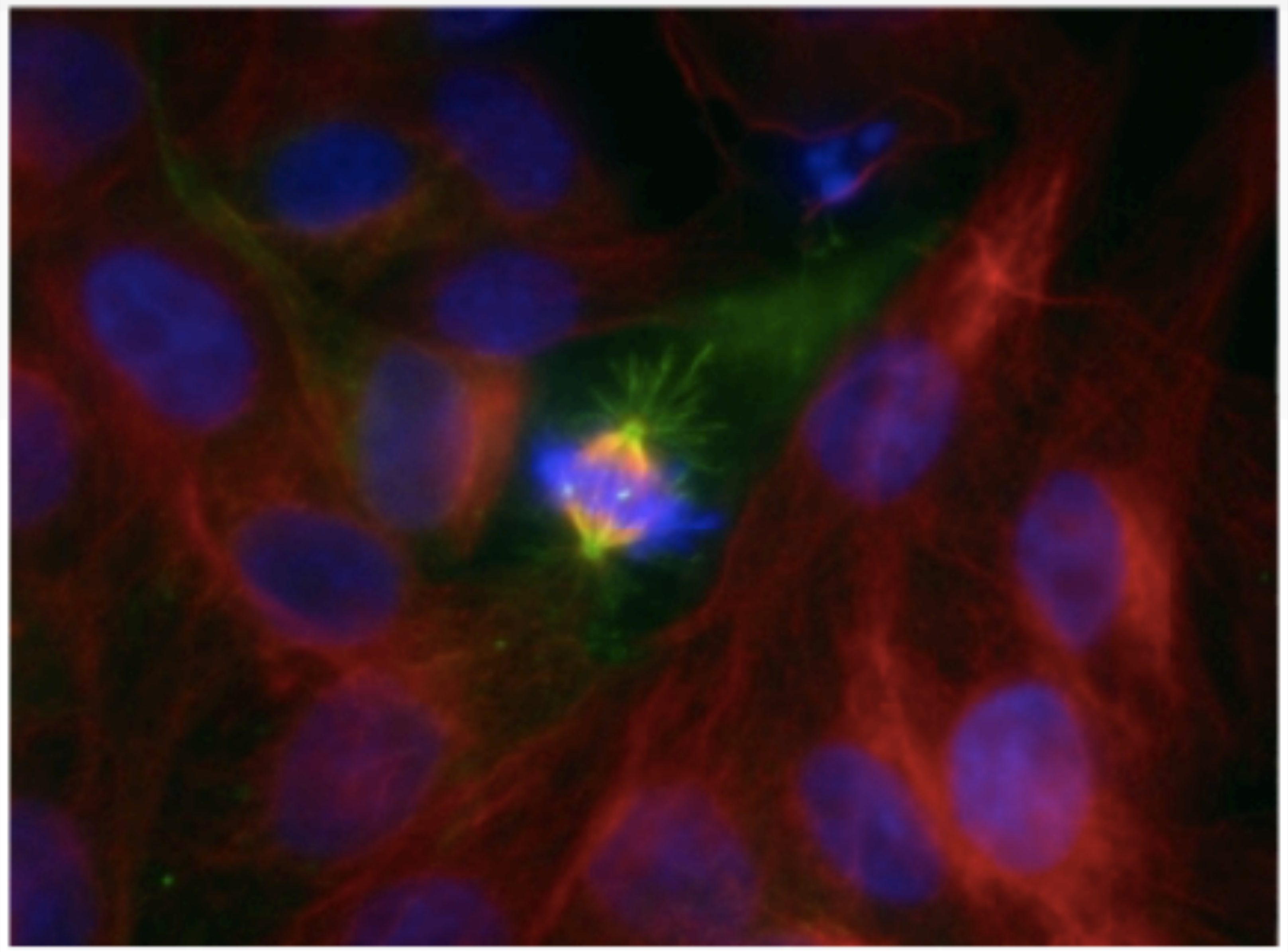
Your BUZZER -> Hit **Reactions** and choose “clapping hands”

END

Pop Quiz!

Chapter 3: Reproduction and Cell Division



You learned in Chapter 1 that DNA is the heritable material, but there are many unanswered questions about how heredity works. For example, if half your DNA is from your mother and half is from your father, why don't you and your siblings have exactly the same DNA and look like identical twins? Why are some traits and diseases passed from one generation to the next, but others are not? How can an inherited trait skip generations?

The key to understanding heredity is to understand how cells divide and pass DNA information to the newly produced cells. Gregor Mendel, a 19^{th} century amateur geneticist, was able to explain many characteristics of heredity that had mystified the professional biologists of his time. In this chapter, you will learn how to predict patterns of inheritance and how organisms passed their genetic information to future generations. Cell division processes are different between eukaryotes, prokaryotes (bacteria) and, haploid gametes (eggs and sperm). Adults produce haploid gametes, with half the diploid-amount of DNA, in a slightly different way than they produce diploid cells. Yet all these cell division processes use similar proteins, as would be expected given their common evolutionary history. {*Connections: the Big Idea of Evolution is discussed explicitly in six chapters.*} The five sections of Chapter 3 focus on information at the organismal level.

Photo courtesy of John Kogoy, Davidson, NC.

you are here		Big Ideas of biology				
		Information	Evolution	Cells	Homeostasis	Emergent Properties
levels of the biological hierarchy	molecules	1	4	7	10	13
	cells	2	5	8	11	14
	organisms I	3	6	9	12	15
	organisms II	16	19	22	28	25
	populations	17	20	23	29	26
	ecological systems	18	21	24	30	27

Week 7

(Preparing for) **Tuesday's lecture:**

Budgeting homework time (60 min): Chapter 3, first 2/3's of section 3.1 is 2160 words in length with 7 figures that require thinking and notetaking. Reading at 200 words per minute would mean the section might take just 12 minutes to read. Of course, when done properly, when you pause to review figures, try Integrating Questions, and take notes, this assignment will take you more like 60 minutes. It could be shorter if you have been doing homework regularly, ie. training like an athlete, and getting stronger, better, faster at this now that it is week 7. Special Allowance today*: If you wish your group can designate who will be responsible for each figure.

1. _______ **For Tuesday's lecture,** read section 3.1 on Gregor Mendel titled "How can traits disappear and reappear in a later generation?" Take careful notes by hand.

2. _______ **Try to answer some Integrating Questions and Review Questions**. As you read the ICB textbook always attempt to test yourself a little, answer at least one of each set.

3. _______ (Trifecta): **Prepare to explain (aloud) Figures 3.3, 3.4, 3.6 and 3.7 in class**. *Special Allowance today*: If you wish your group can designate who will be responsible for each figure and thus split up the responsibility and reduce the load (Purpose, Methods, Findings).

4. _______ **Advanced**: Review how to use Punnett squares to predict the outcome of crosses.

Chapter 3 ICB Reading 3.1 Mendel

"How can traits disappear + reappear in a later gene
(B.L. Mendels rules of inheritance explain patterns + deviat

L.O.s • Re-state major rules + laws discovered by Me
• Analyze genetic data to demonstrate your comp

Intro

People bred animals for years but nobody understood mech
1865 austrian monk Gregor Mendel started "genetics"
published a paper that explained it (41 page paper see o
Genetics = study how genotypes + phenotypes are prop
through sexual reproduction.

Mendel studied variety of plants + conducted thousands of ex
His super power was use of math and high trial number
Chose Pea Plant as organism. Had lots of experience with
of plant's flower ideal to control pollination. A vault, usu
Mendel first worked for two years to be sure traits he wa
were stable over many generations. → "true breedi
Eventually chose 7 traits (of 22 stable ones) to study in

Figure 3.1 – Pea/flower anatomy
Figure 3.2 – Pea plant life cycle

↳ flowers produce gametes of pollen + eggs (via meiosis)
"stamen = male → pollen (haploid) ⇝ up to → "stigma" at top of
organ
Pollen lands → [struck out] → pollen tube to the egg union → fertilize → seed
(like sperm) adheres (grows/burrows)

In 1860's Biologist thought/published → "blending" occurse
Mendel never observed "blending" in his plants traits
Study #1

Figure 3.3 – illustration of Mendel's results if true-breed
YY yellow pea plant X cross (reciprocal cross) yy green pea plant Pare
(pollen or egg) ⟷ (pollen or egg) childr

IQ 1+2 dominant?

Mendel (cont.) 3.1

Q: Why is something dominant? F_1 children are all Yellow because the have a big Y that dominates (?) little y, but HOW what happens?

Trifecta Mendel's Study #1

Purpose: Learn if traits "blend" or not when true-breeding parent plants are crossed.

Methods: 1. Grow a true-breeding pea plant [with that will produce yellow seeds (peas)] but before it goes to seed, while juvenile, take small scissors or forceps and remove stamen ♂ (has filament + anther) so cannot produce pollen
2. Grow (ing) to in another garden plot true-breeding (green pea) Pea Plants, use tiny paint brush, hold open flower petals and use brush to capture lots of pollen dust from top of stamen ♂ (the anthers).
3. Go to the vesectomy yellow pea plant and brush pollen onto it's stigma ♀.
4. Grow crossed exp plants to "seed" then plant seeds + grow F_1 children until they seed, check pea colors count

Findings: F_1 were 100% Yellow peas, no "blending" found.

NOTE: Mendel's paper: 1866: "Experiments in plant hybridisation" ("Versuche über plflanzenhybriden")

Laws: Segregation → traits sorted seperately ← Independent Assortment
↘ Parent only donates one factor (of two they have)

"Mendel finds repeating pattern...
Study #4
Focusing on F_2 seeds (Fig. 3.4): Noticed when planted green pea seeds + they self-pollinate → only got plants that produced "green" seeds (peas) F_3
"little" → "homozygous"

repeating patterns... (cont.)
4 (cont)

all the yellow seeds, produced from F_2 plants → some (1/3) homozygous [YY]
nly yellow F_3, but many (2/3) produced 3:1 plants that yellow : green seeds

[YY] true-breeding ~~homozygous~~ [Yy] hetrozygous [YY] + [Yy] [yy]
1/4 1/2 1/4
yellow peas green peas true-breeding

combining old knowledge + modern showing paired chromosomes
h pea seed (diploid organism like humans)

: Peas have seven (pairs) of chromosomes in their nucleus plants cells
ied seven traits, turns out each on different chromos

Mendel's contemporaries (other scientists) not
e results? Why think "BLENDING"?

illustration attempting to show the single chromosome
n gametes of pea plant pollen + egg vary
chance plays a role in any particular pea formed (seed)

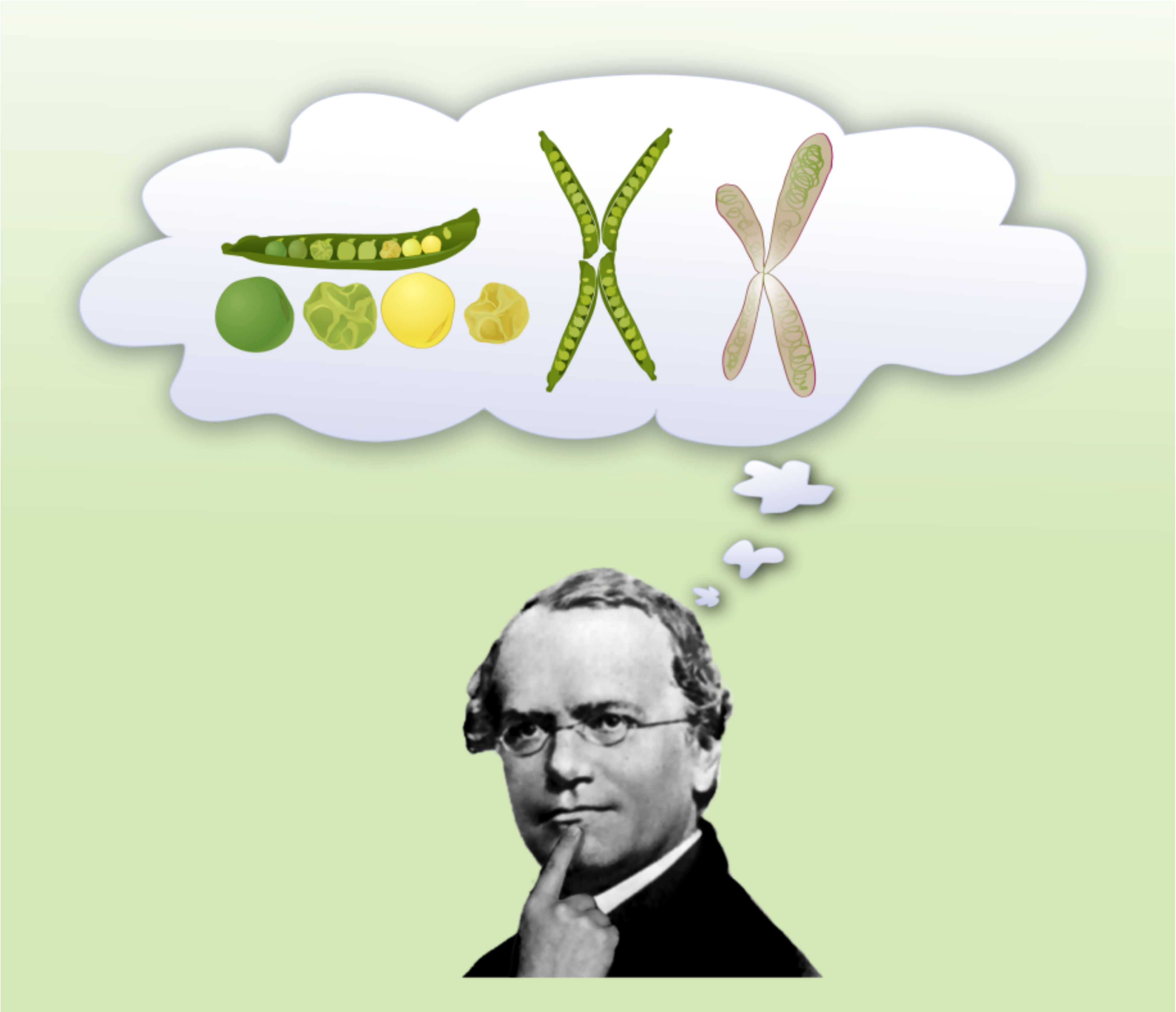
uares attempt to help one cross the gametes
left side, egg's along top

╱╱╱	eggs Y	y
Y		
y		

← possible combinations in cross

Biology Learning Objectives

- Restate the major rules and laws discovered by Gregor Mendel.
- Analyze genetic data to demonstrate your comprehension of inheritance patterns.



Pea trait	Dominant trait	Recessive trait
Seeds		
Seed shape	Round	Wrinkled
Seed colour	Yellow	Green
Whole plants		
Flower colour	Purple	White
Flower position	Axial	Terminal
Plant height	Tall	Short
Pod shape	Inflated	Constricted
Pod colour	Green	Yellow

?

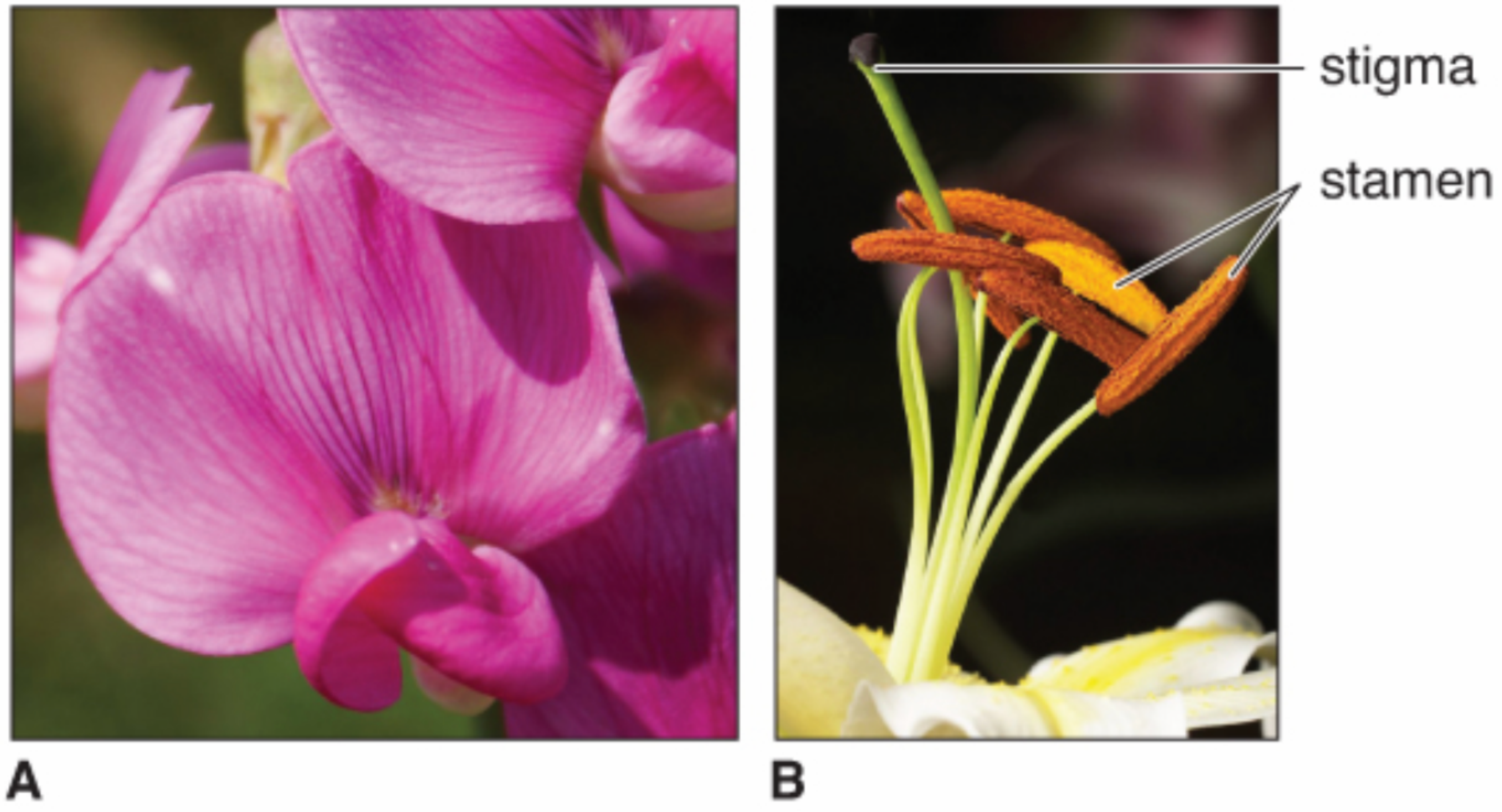


Figure 3.1 Flower parts. **A,** Pink pea flower with reproductive parts hidden inside. **B,** Open flower (not a pea species) with reproductive parts exposed and labeled. A. Author: Gilligone. 2008. This work is licensed under the Creative Commons Attribution-ShareAlike 3.0 License. B. Author: JJ Harrison. This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.

Mendel's Model System: pea plants

pea flower is closed

reproductive parts hidden

"self cross"-one flower can self-pollinate without need for another flower

Fig. 3.1

A: Gilligone. 2008. and B: JJ Harrison

Flower Anatomy

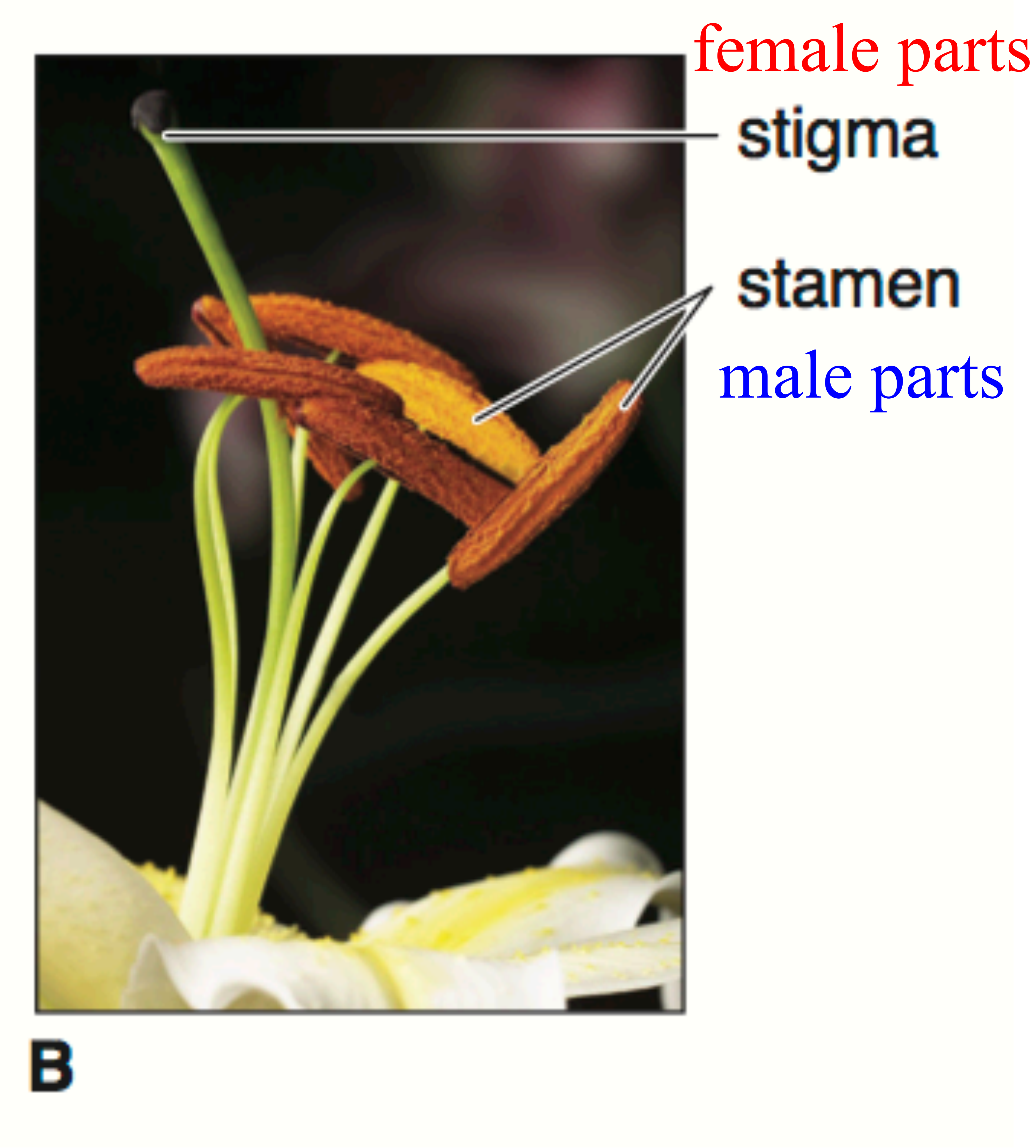


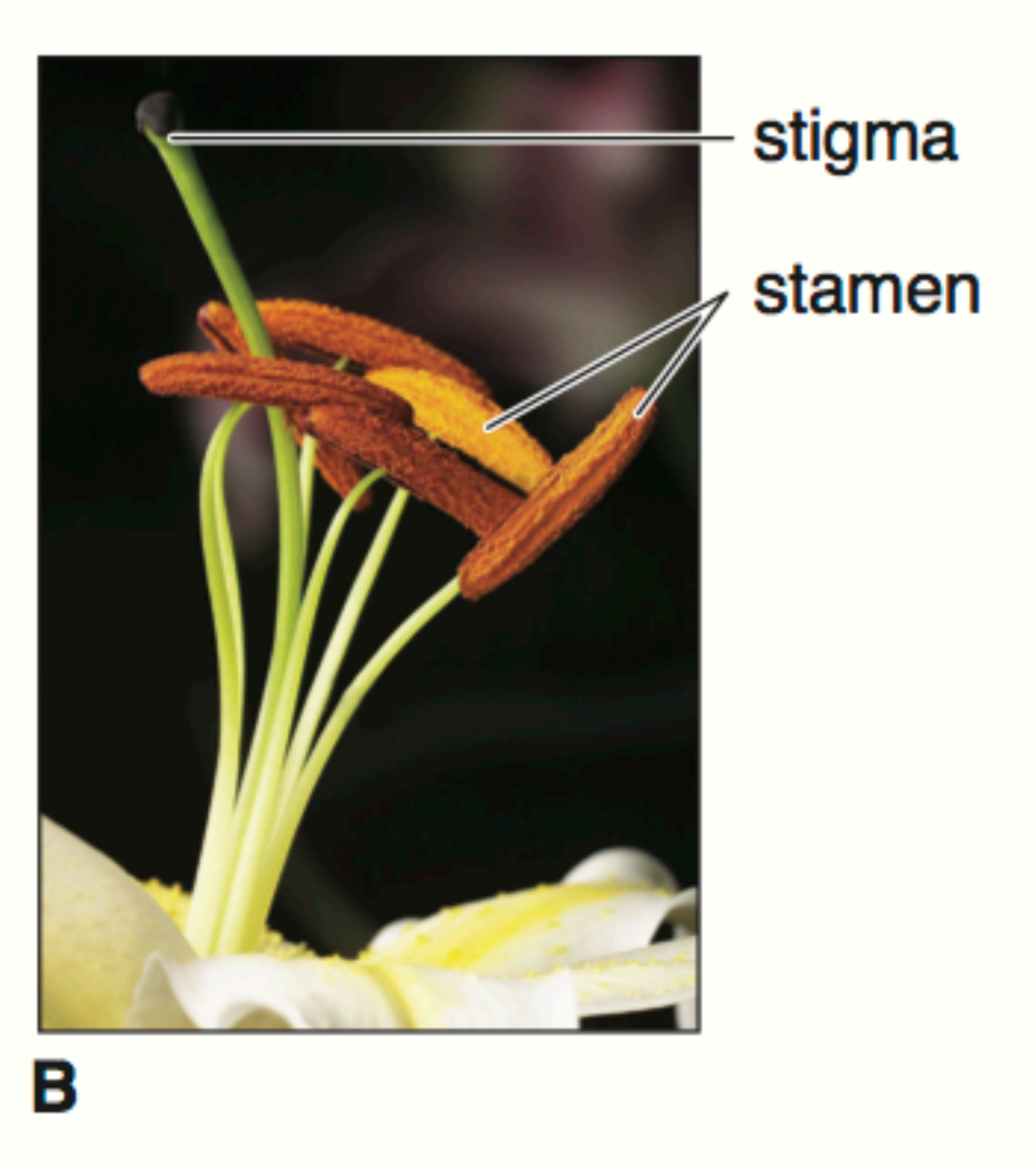
Fig. 3.1

A: Gilligone. 2008. and B: JJ Harrison

Flower Anatomy

possible to remove only male or female parts for controlled matings

Prevent "self cross"-hence can manually cross 2 plants



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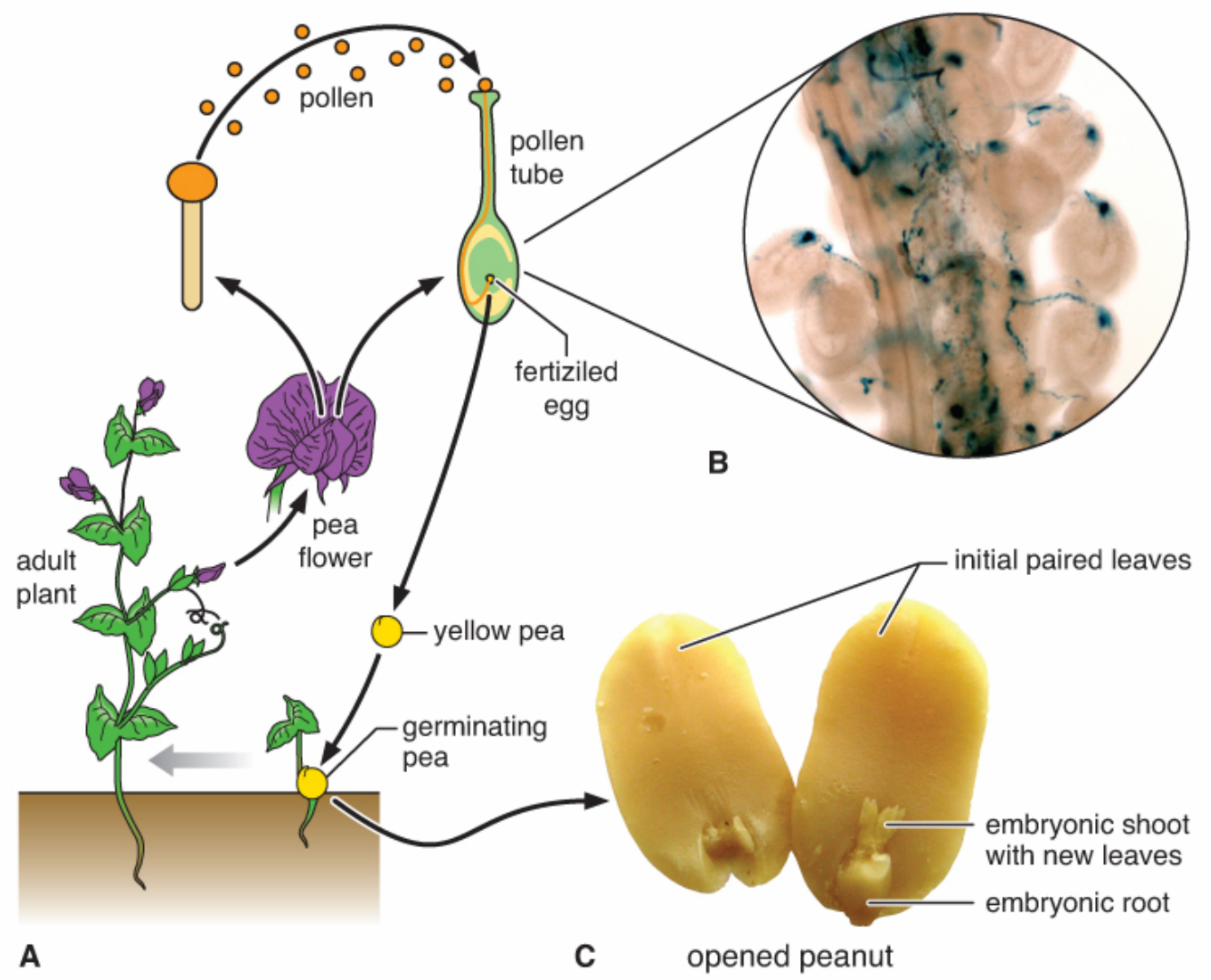


Figure 3.2 Pea plant life cycle and parts of a seed. **A,** Diagram of pea life cycle including self-fertilization. **B,** Photomicrograph of thin, blue-stained pollen tubes fertilizing eggs (larger blue circles). **C,** Like peas, peanuts contain paired embryonic leaves and a root inside. A. original art. B.

Pea Plant Life Cycle

one pea plant

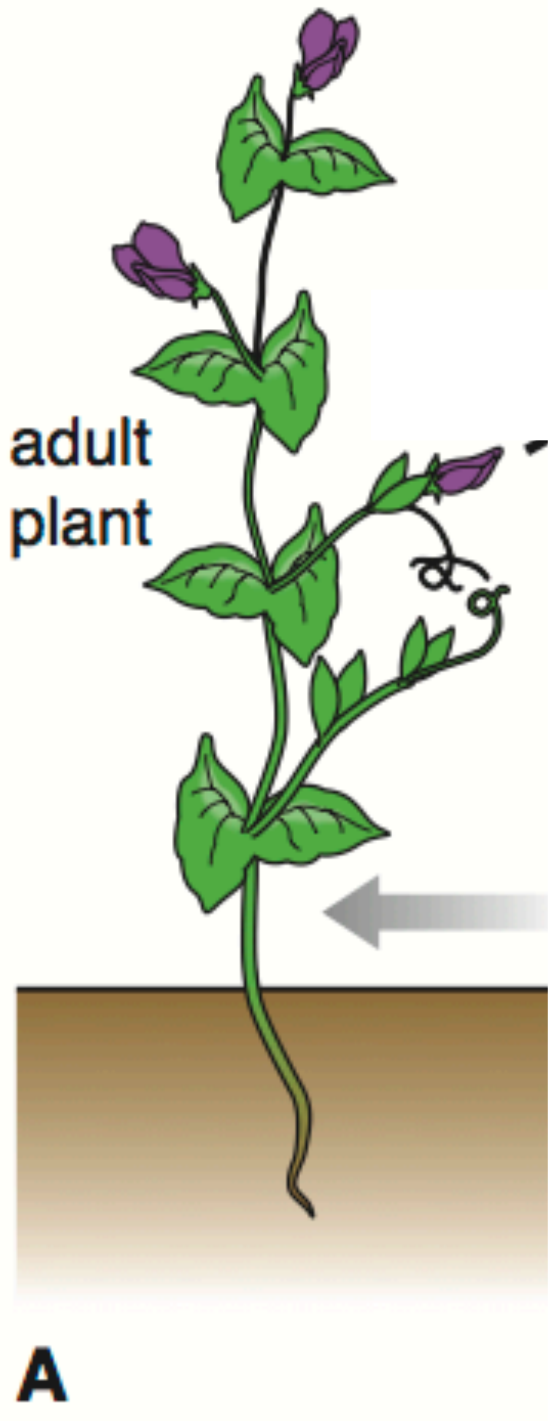
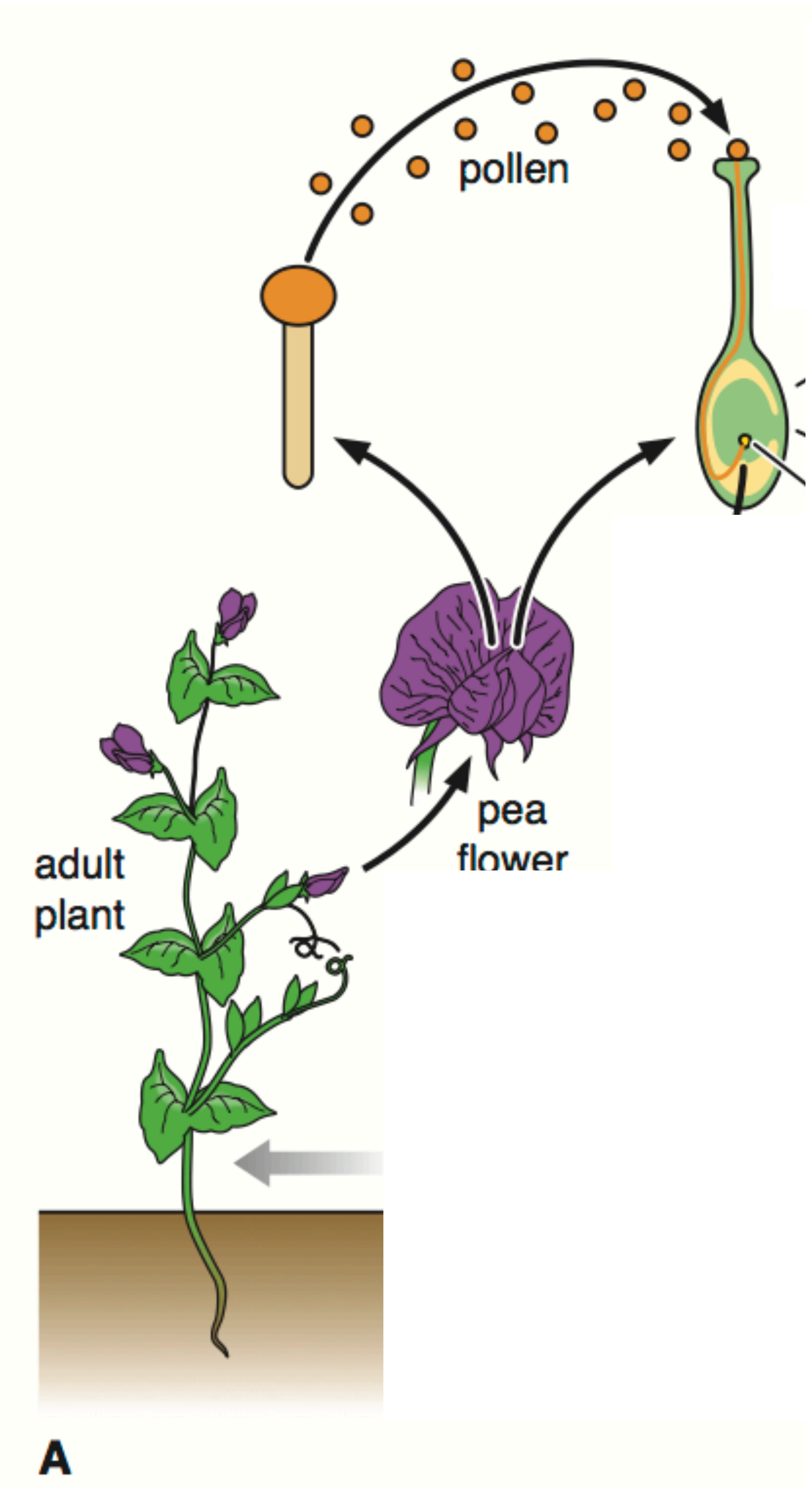


Fig. 3.2

B: Higashiyama and Hamamura

Pea Plant Life Cycle

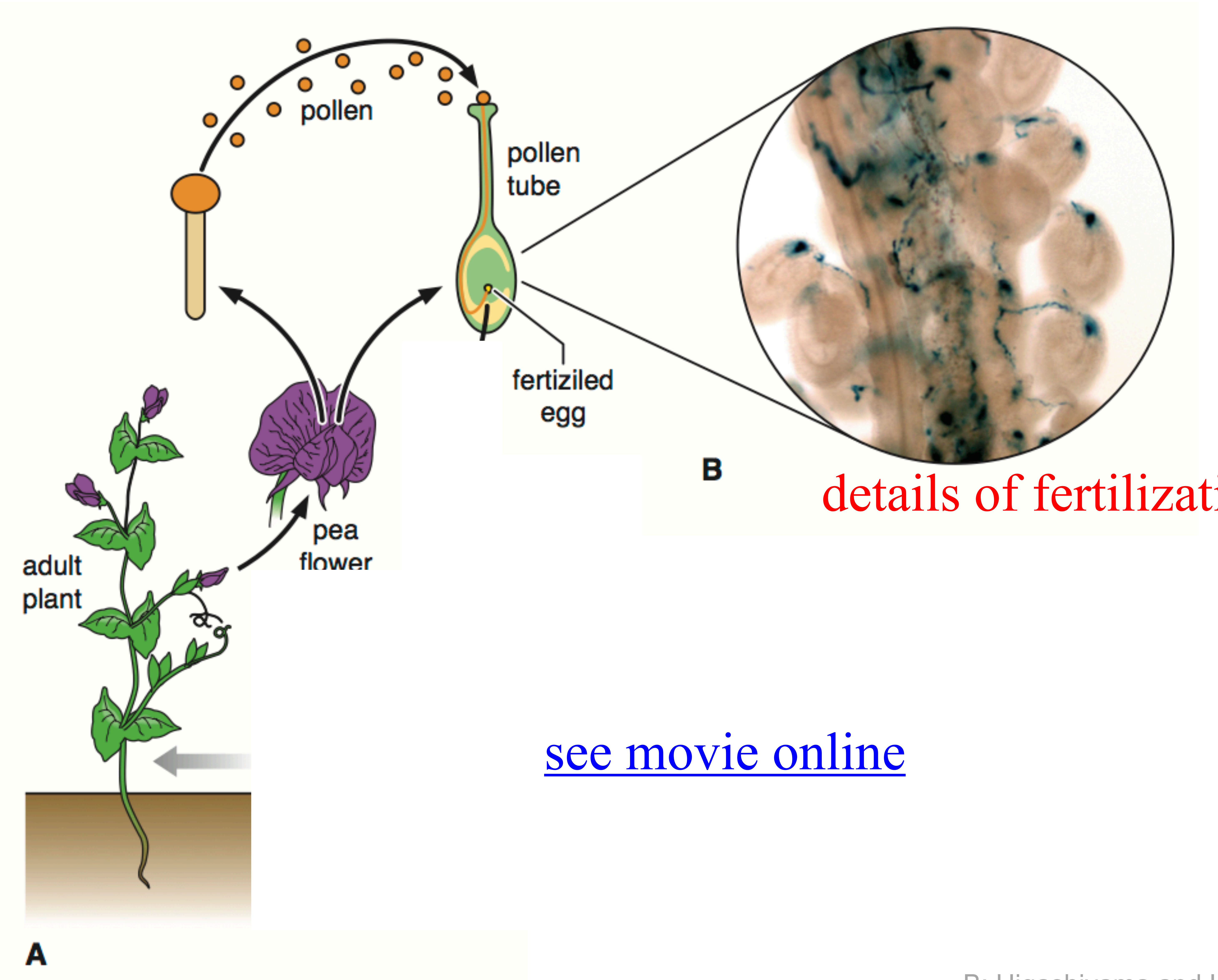


flower self-pollinated

Fig. 3.2

B: Higashiyama and Hamamura

Pea Plant Life Cycle



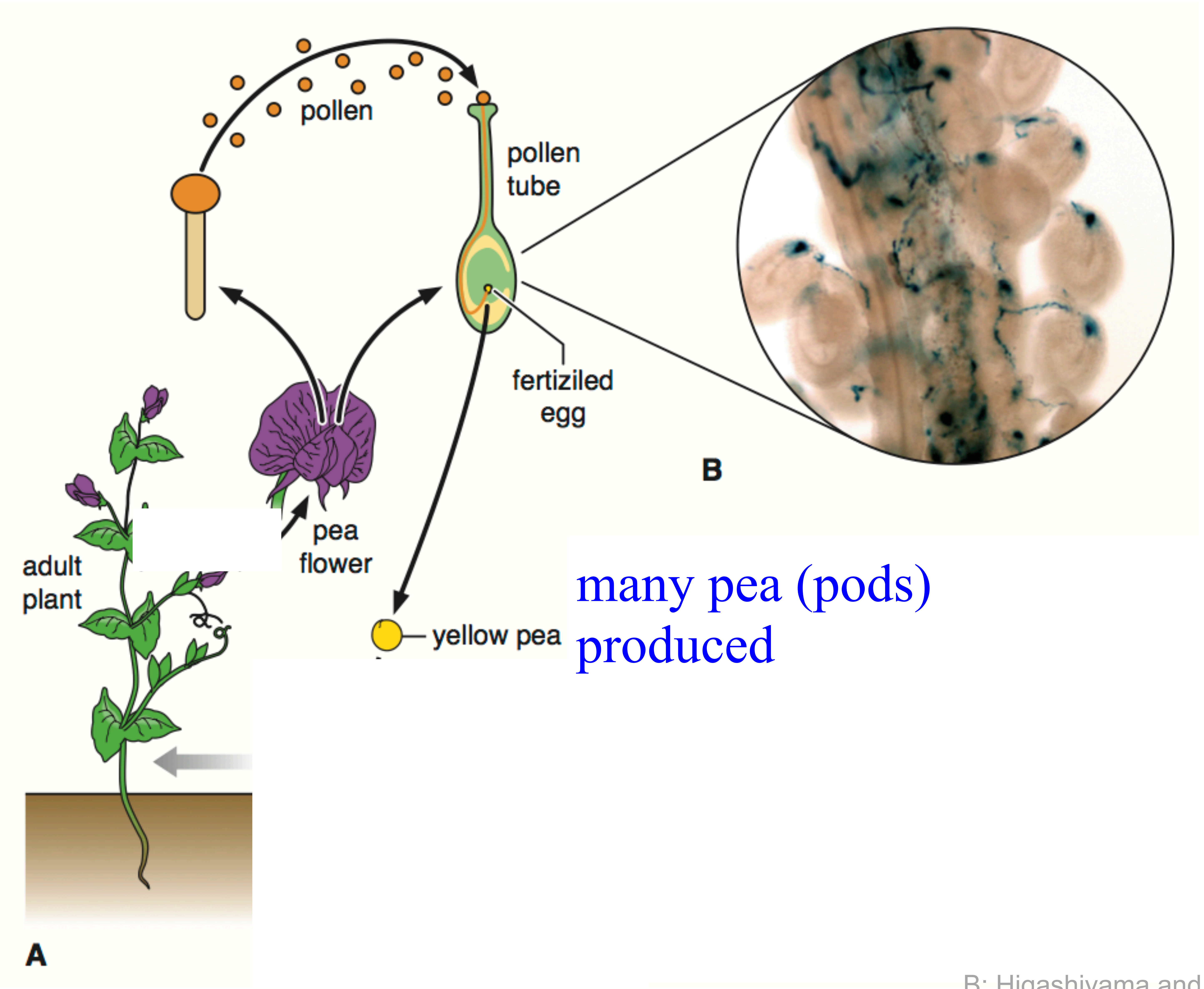
details of fertilization

see movie online

Fig. 3.2

B: Higashiyama and Hamamura

Pea Plant Life Cycle



many pea (pods) produced

Fig. 3.2

B: Higashiyama and Hamamura

Pea Plant Life Cycle

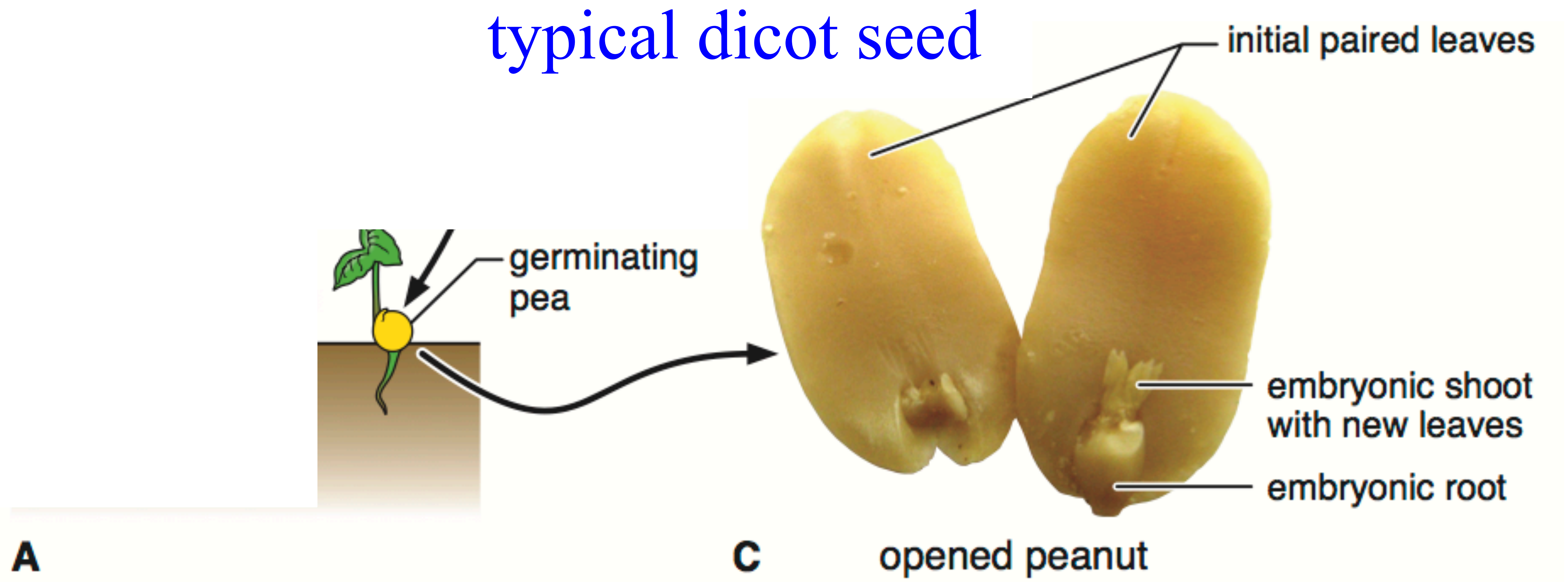


Fig. 3.2

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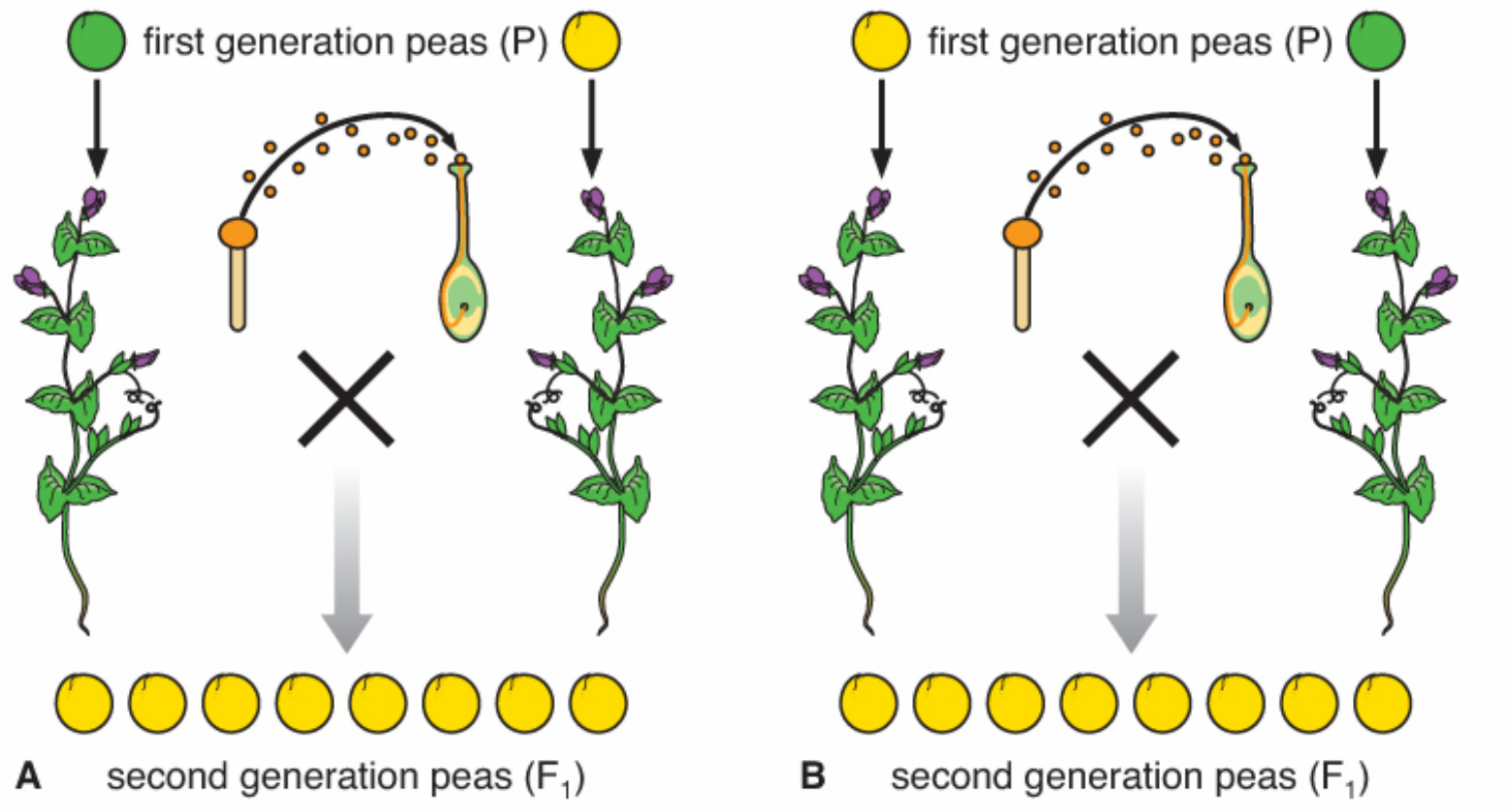


Figure 3.3 Mendel's first breeding results. **A,** Pollen from true-breeding green pea plants and eggs from true-breeding yellow pea plants produced only yellow seeds. **B,** The reciprocal cross also produced only yellow seeds.

Mendel's First Experiment

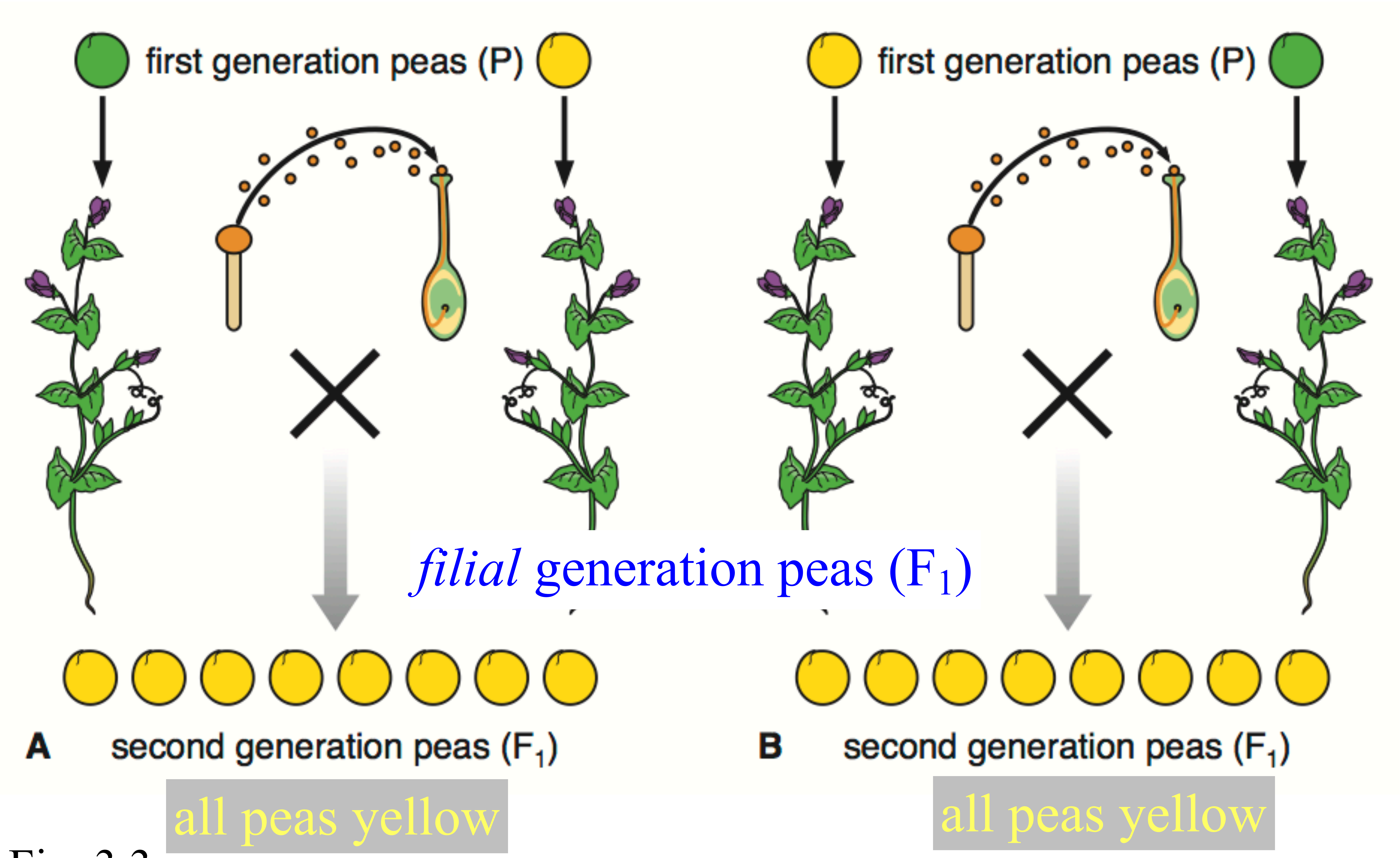
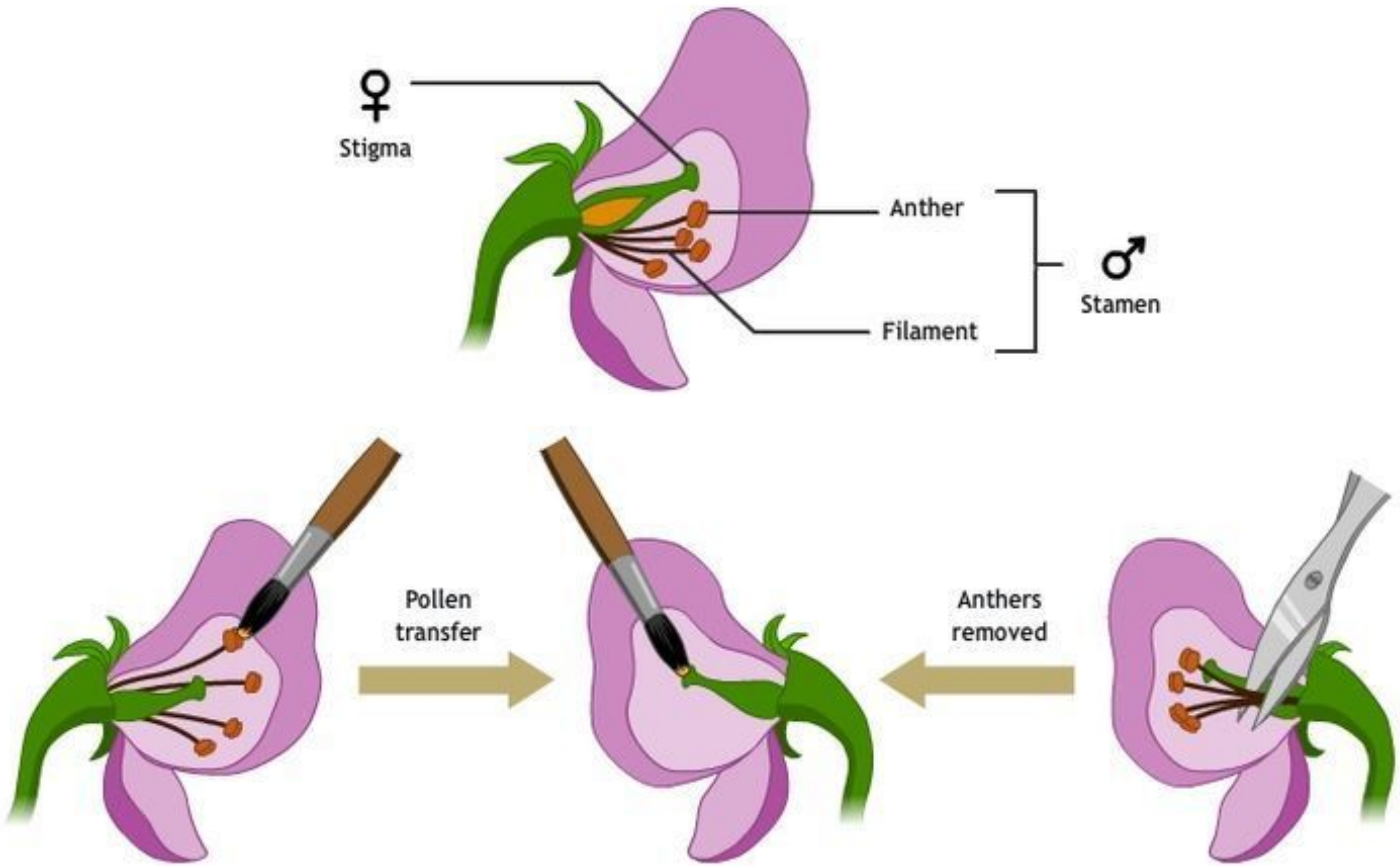
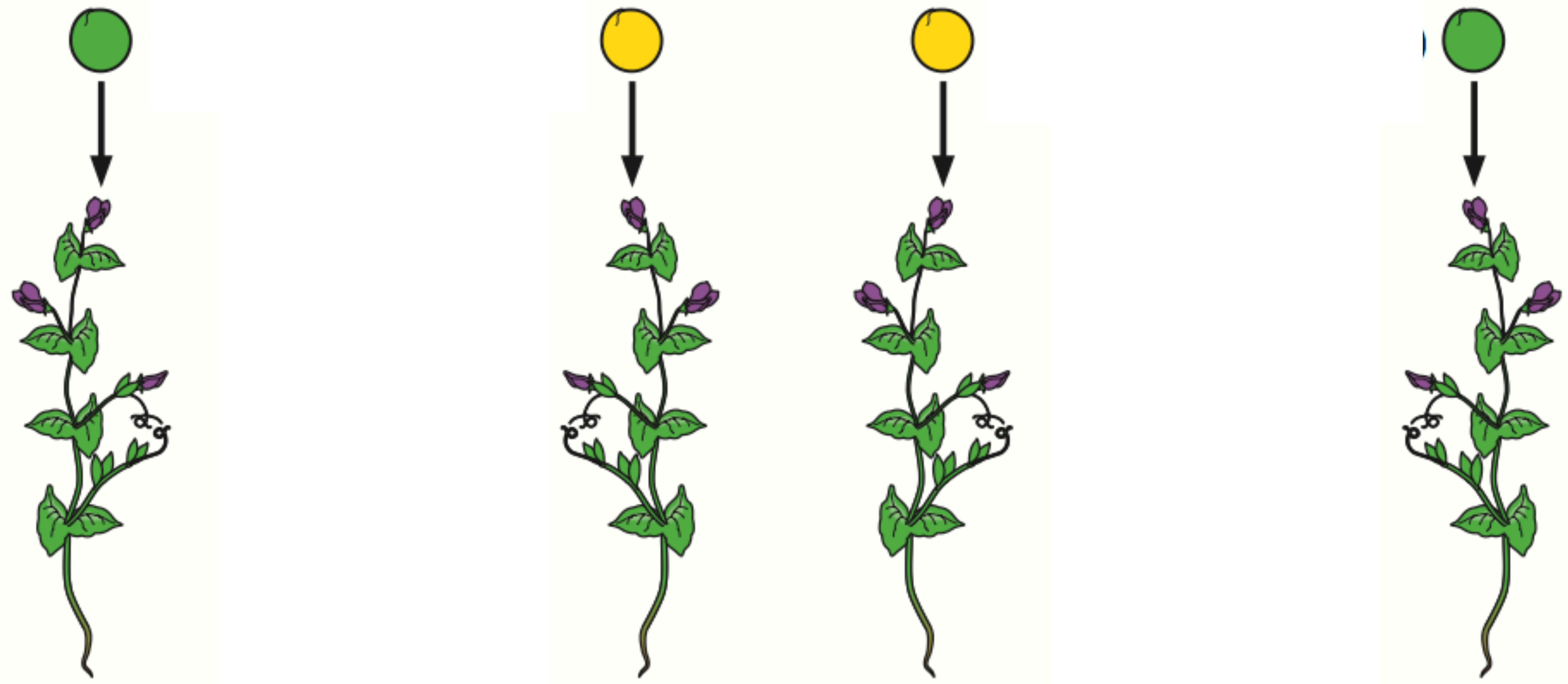


Fig. 3.3

Mendel's First Experiment (Methods)



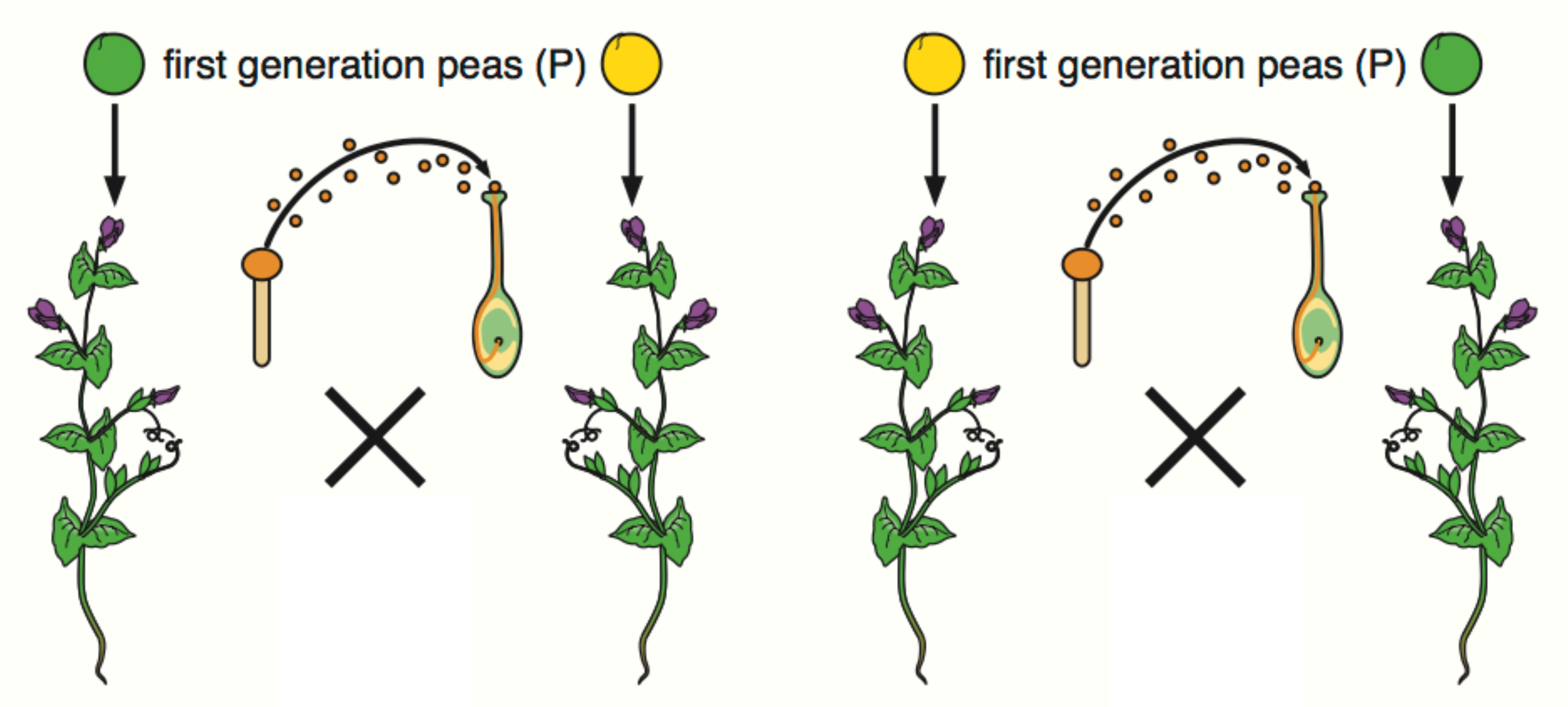
Mendel’s First Experiments



each pea produces one plant

Fig. 3.3

Mendel's First Experiments



Male/ pollen

Female /egg

Male/ pollen

Female /egg

parental generation plants (P)

Fig. 3.3

Mendel's First Experiments

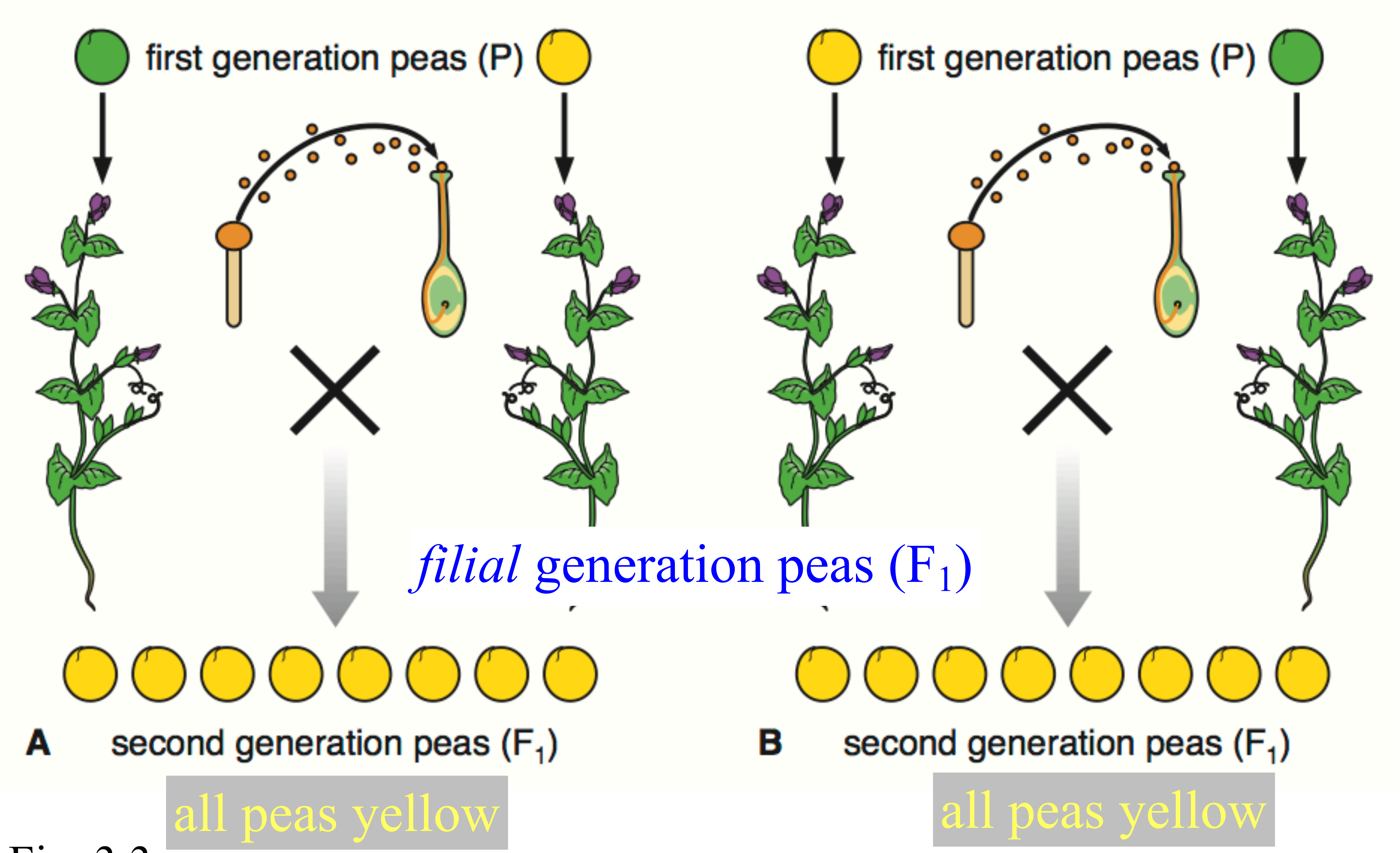
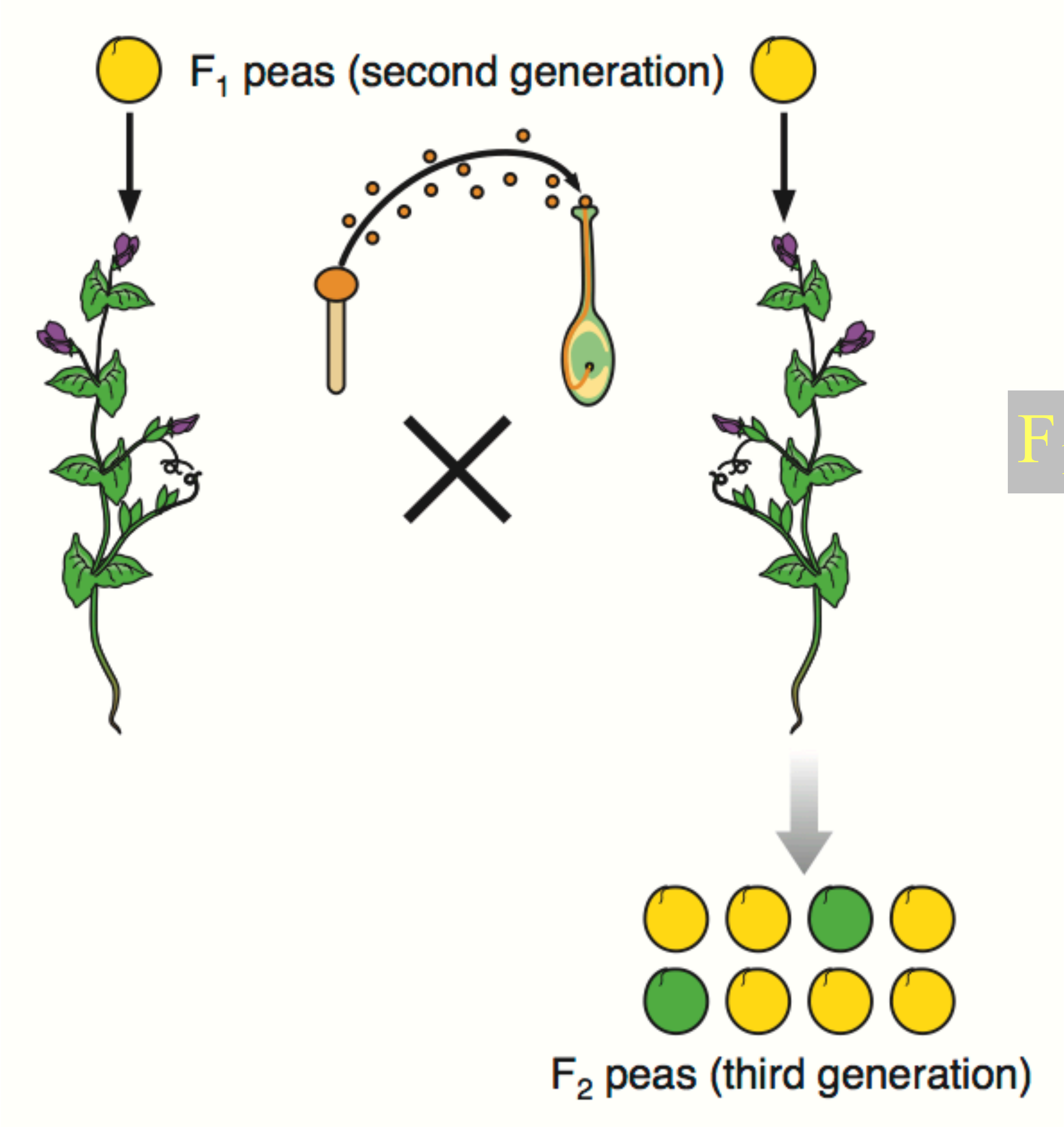


Fig. 3.3

Second Pea Mating Experiment

F_1 plant

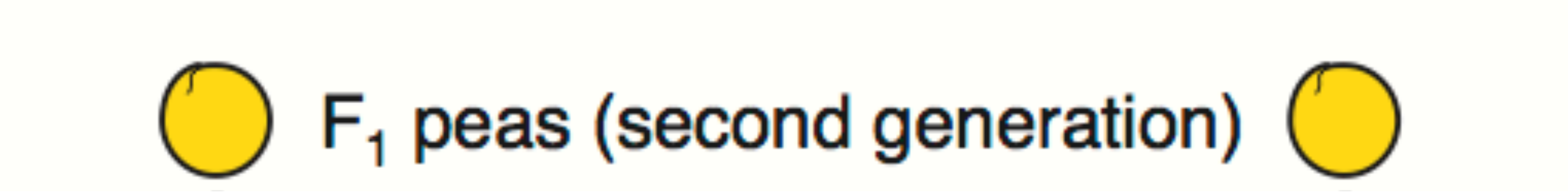


F_1 plant

Fig. 3.4

Second Pea Mating Experiments

F_1 pea

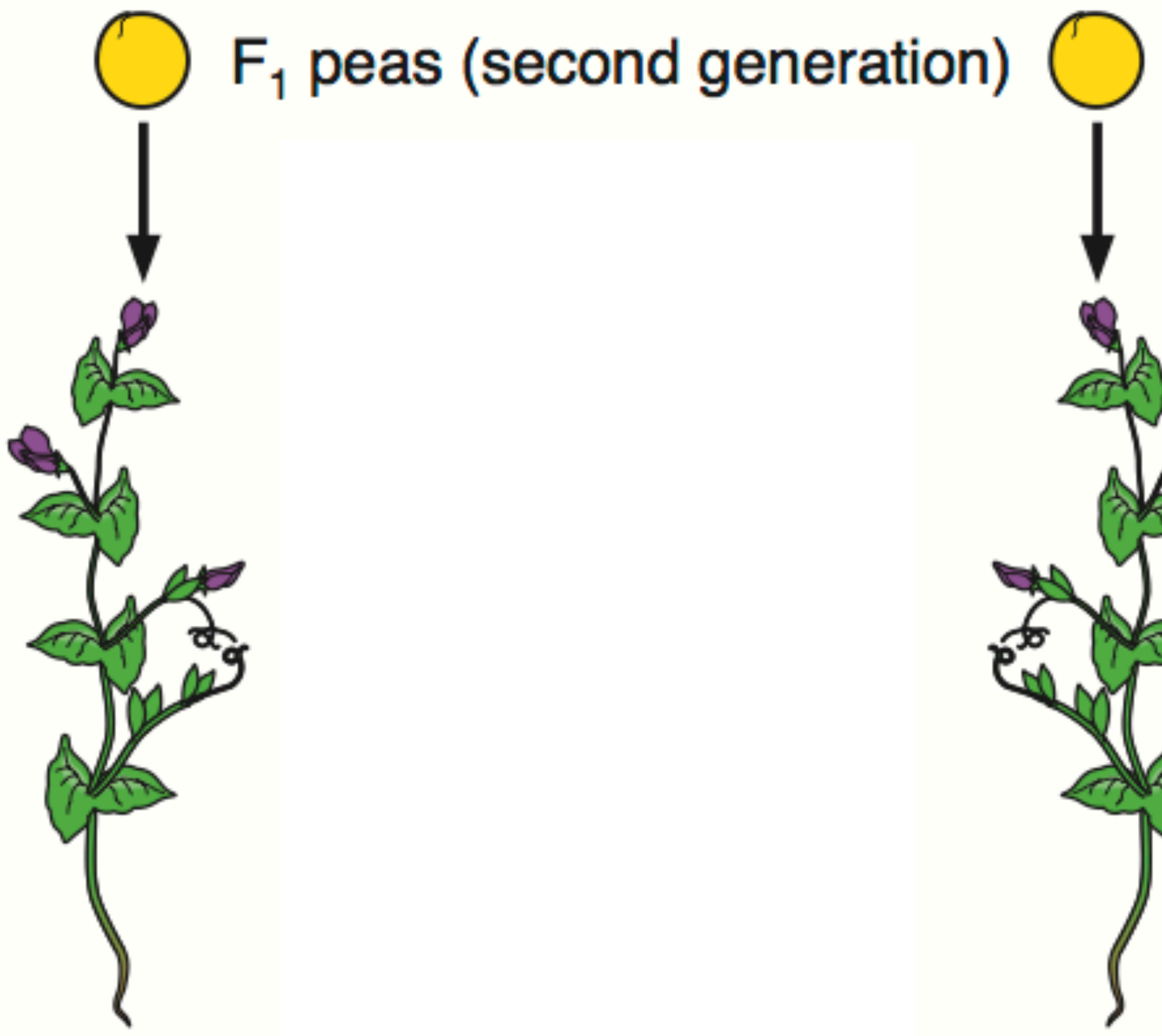


F_1 pea

Fig. 3.4

Second Pea Mating Experiments

F_1 pea



F_1 pea

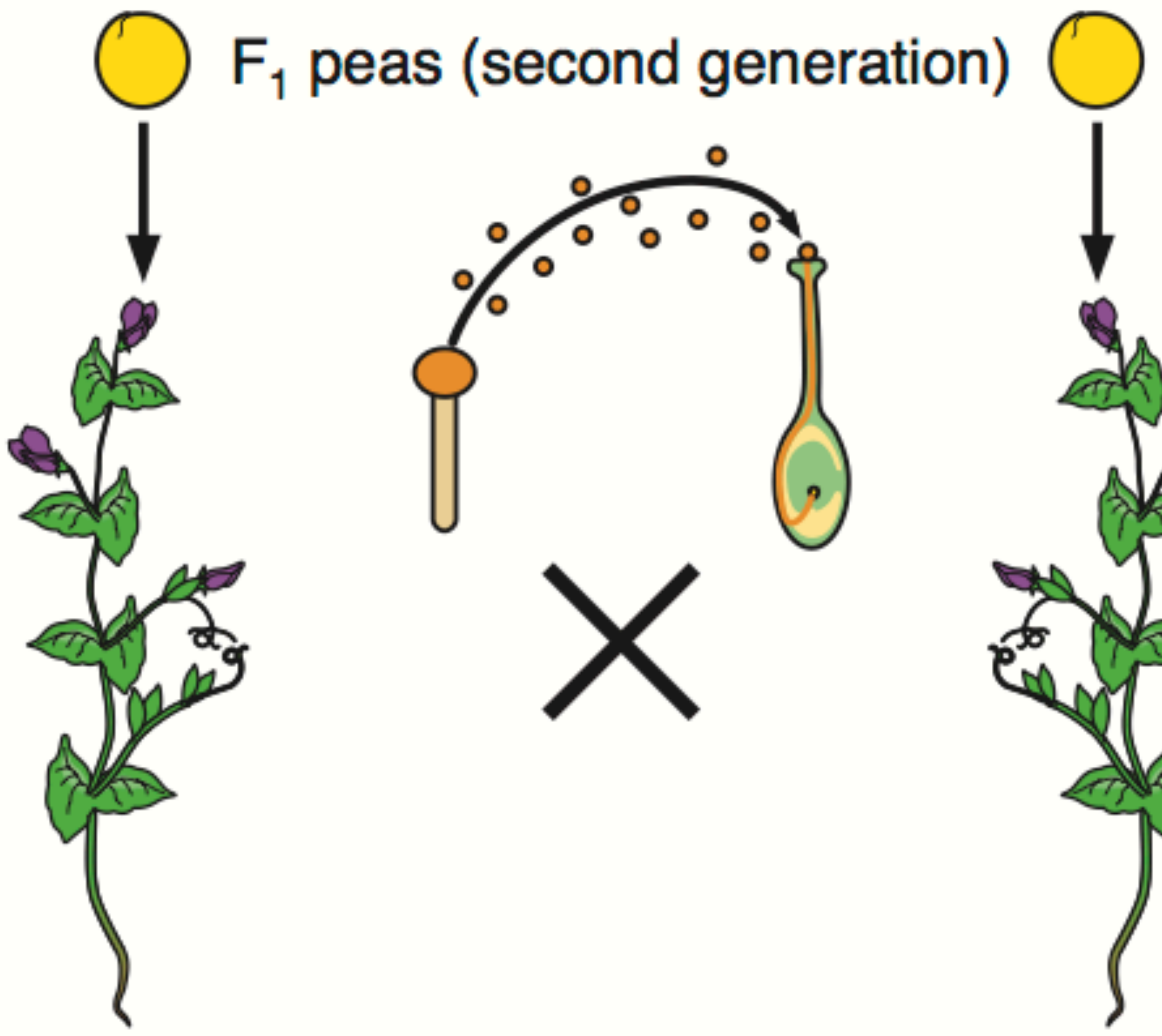
F_1 plant

F_1 plant

Fig. 3.4

Second Pea Mating Experiments

F_1 plant

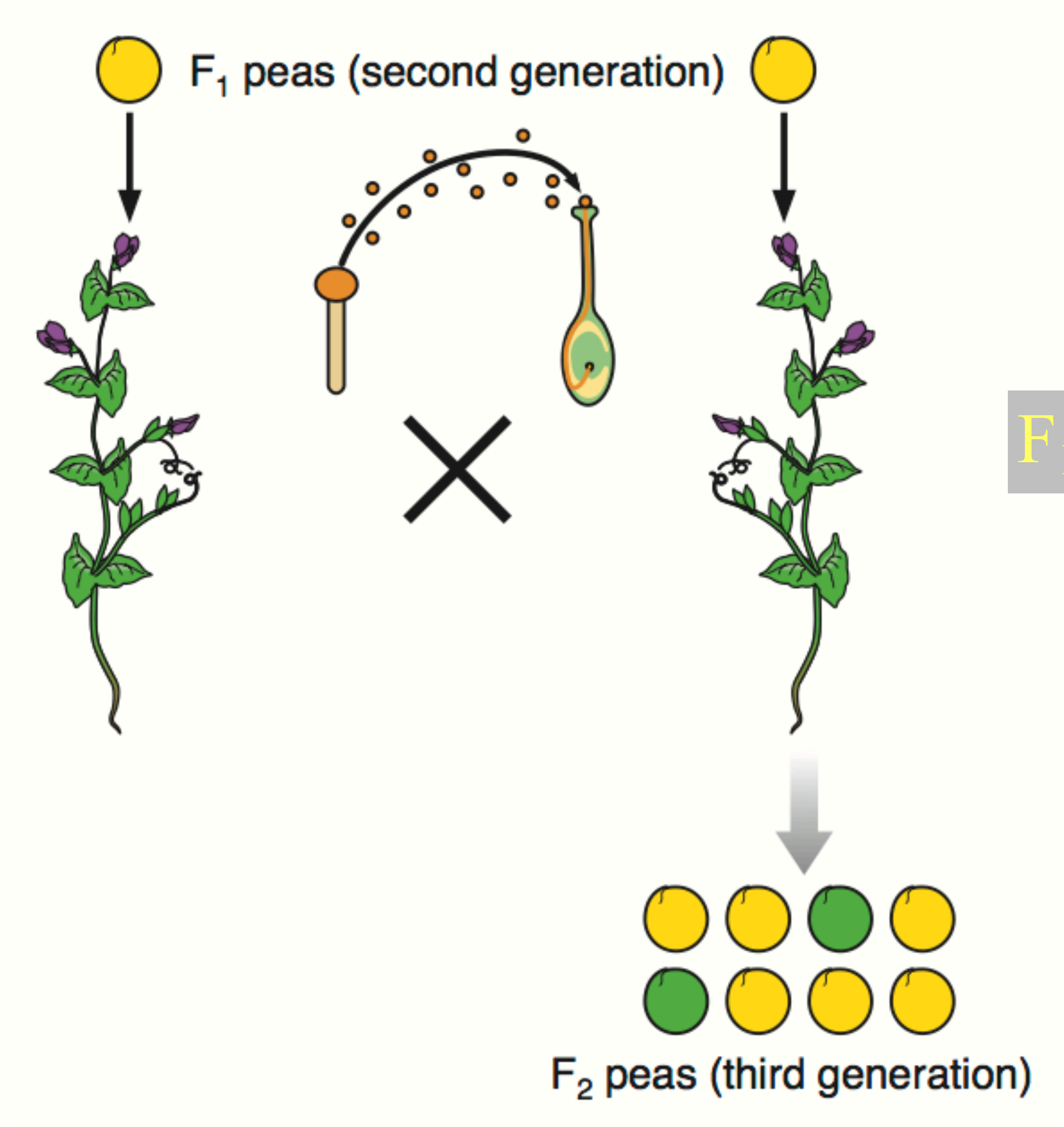


F_1 plant

Fig. 3.4

Second Pea Mating Experiments

F_1 plant



F_1 plant

Fig. 3.4

?

generation	green peas	yellow peas
P	5 true-breeding green plants	5 true-breeding yellow plants
F_1	0 green peas	273 yellow peas
F_1	0 plants from green peas	self-cross 258 plants from F_1 yellow peas
F_2	2,001 green peas	6,022 yellow peas

Table 3.1 Results from mating true-breeding plants that produced yellow or green peas. Data from Mendel.

Table 3.1

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F_1	0 plants from green peas	self-cross 258 plants from F_1 yellow peas
F_2	2,001 green peas	6,022 yellow peas

1 : 3 ratio of green to yellow peas (F_2)

Table 3.1

data from Mendel.

Table 3.1

Table 3.1 Results from mating true-breeding plants that produced yellow or green peas.

generation	green peas	X	yellow peas
P	5 true-breeding green plants		5 true-breeding yellow plants

Table 3.1

data from Mendel.

Table 3.1

Table 3.1 Results from mating true-breeding plants that produced yellow or green peas.

generation	green peas	yellow peas
P	5 true-breeding green plants	5 true-breeding yellow plants
F_1	0 green peas	273 yellow peas

all F_1 peas yellow (dominant)

outcomes after true green X true yellow (P)

Table 3.1

data from Mendel.

Table 3.1

Table 3.1 Results from mating true-breeding plants that produced yellow or green peas.

generation	green peas	yellow peas
P	5 true-breeding green plants	5 true-breeding yellow plants
F_1	0 green peas	273 yellow peas
F_1	0 plants from green peas	self-cross 258 plants from F_1 yellow peas

grow F_1 plants from yellow peas

Table 3.1

data from Mendel.

Table 3.1

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generation	green peas	yellow peas
P	5 true-breeding green plants	5 true-breeding yellow plants
F_1	0 green peas	273 yellow peas
F_1	0 plants from green peas	self-cross 258 plants from F_1 yellow peas
F_2	2,001 green peas	6,022 yellow peas

1 : 3 ratio of green to yellow peas (F_2)

data from Mendel.

generation	wrinkled peas	smooth peas
P	5 true-breeding wrinkled plants	5 true-breeding smooth plants
F_1	0 wrinkled peas	281 smooth peas
F_1	0 plants from wrinkled peas	self-cross 253 plants from F_1 smooth peas
F_2	1,850 wrinkled peas	5,474 smooth peas

Table 3.2 Results from mating true-breeding plants that produced smooth or wrinkled peas. Data from Mendel.

plant number	smooth pea	wrinkled pea	plant number	yellow pea	green pea
1	45	12	1	25	11
2	27	8	2	32	7
3	24	7	3	14	5
4	19	10	4	70	27
5	32	11	5	24	13
6	26	6	6	20	6
7	88	24	7	32	13
8	22	10	8	44	9
9	28	6	9	50	14
10	25	7	10	44	18
totals	**336**	**101**	**totals**	**355**	**123**

Table 3.3 Variation in F_2 pea phenotypes from 10 F_1 plant self-matings, for two separate traits (20 plants total). Data from Mendel.

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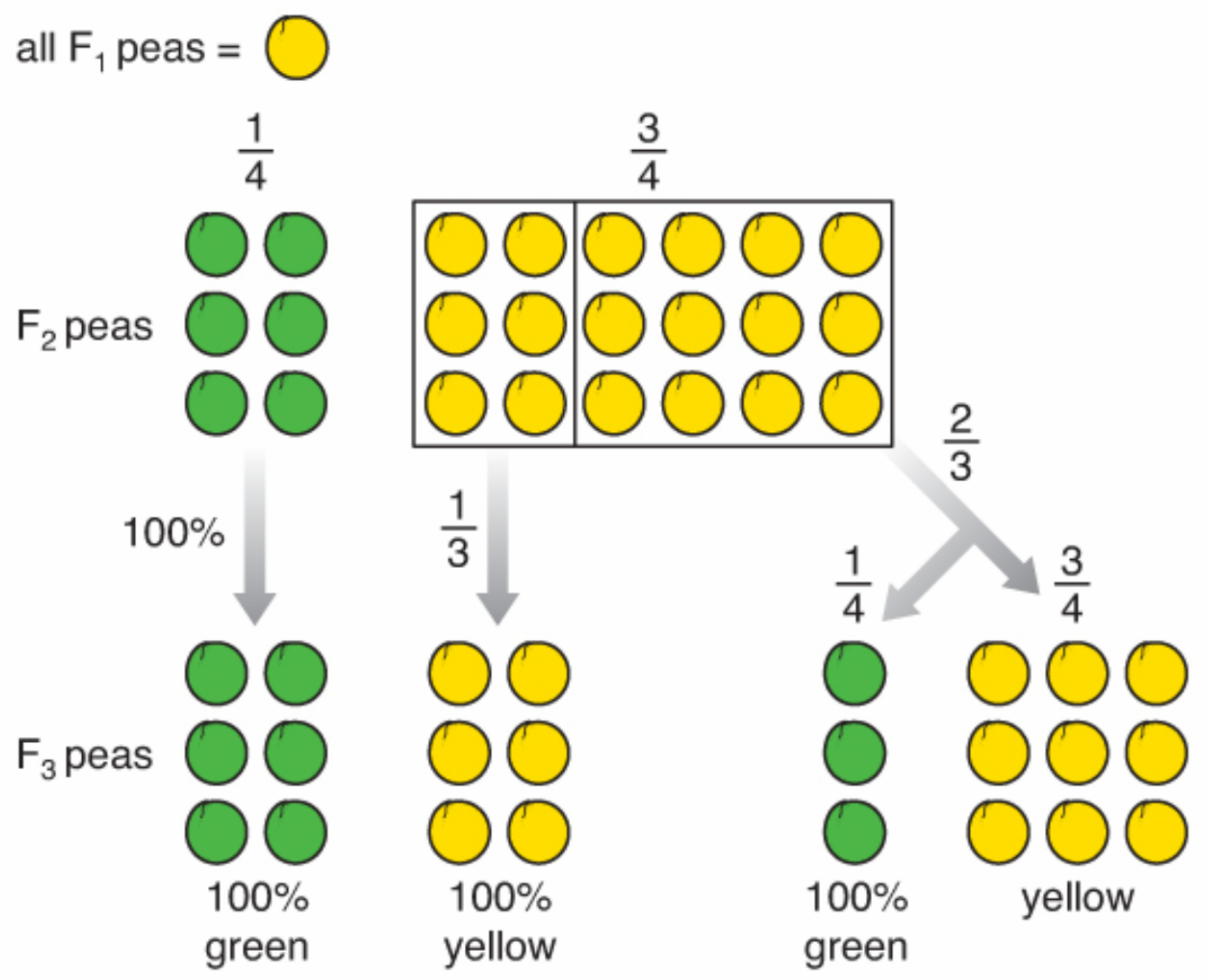


Figure 3.5 Mendel's F_3 results from F_2 pea plants. For illustration purposes, 24 peas were produced in each generation. Results from self-pollinating F_2 plants are shown as F_3 peas. Original art.

?

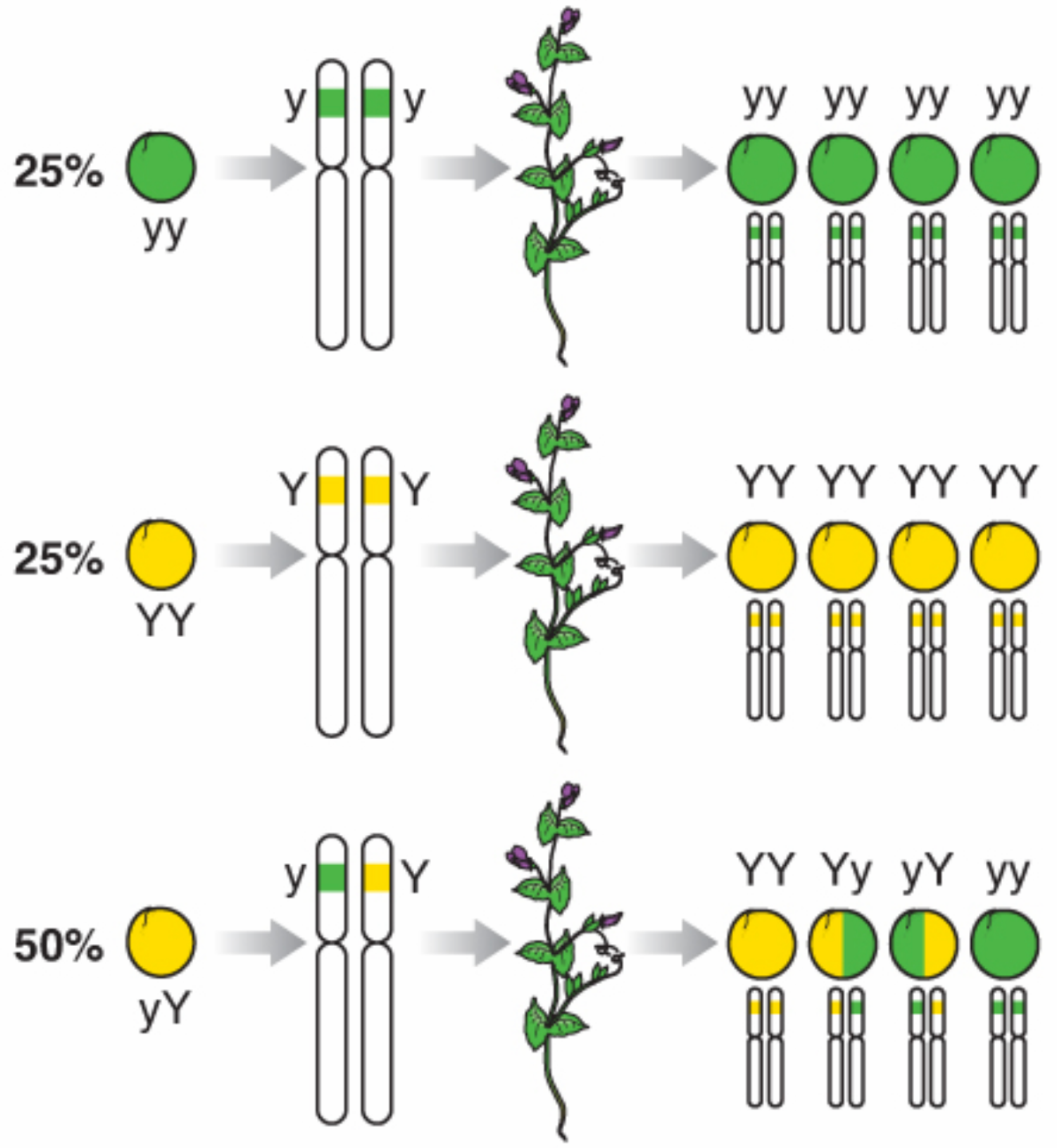


Figure 3.6 Combining Mendel's observations with DNA information. From left to right: F_2 seeds and their genotypes shown as homologous chromosomes with colored alleles. The resulting F_2 plants and the F_3 progeny from F_2 self-pollination. F_3 heterozygotes are shaded half yellow and half green for illustration purposes, but the peas appear fully yellow. Original art.

Yellow pigment?

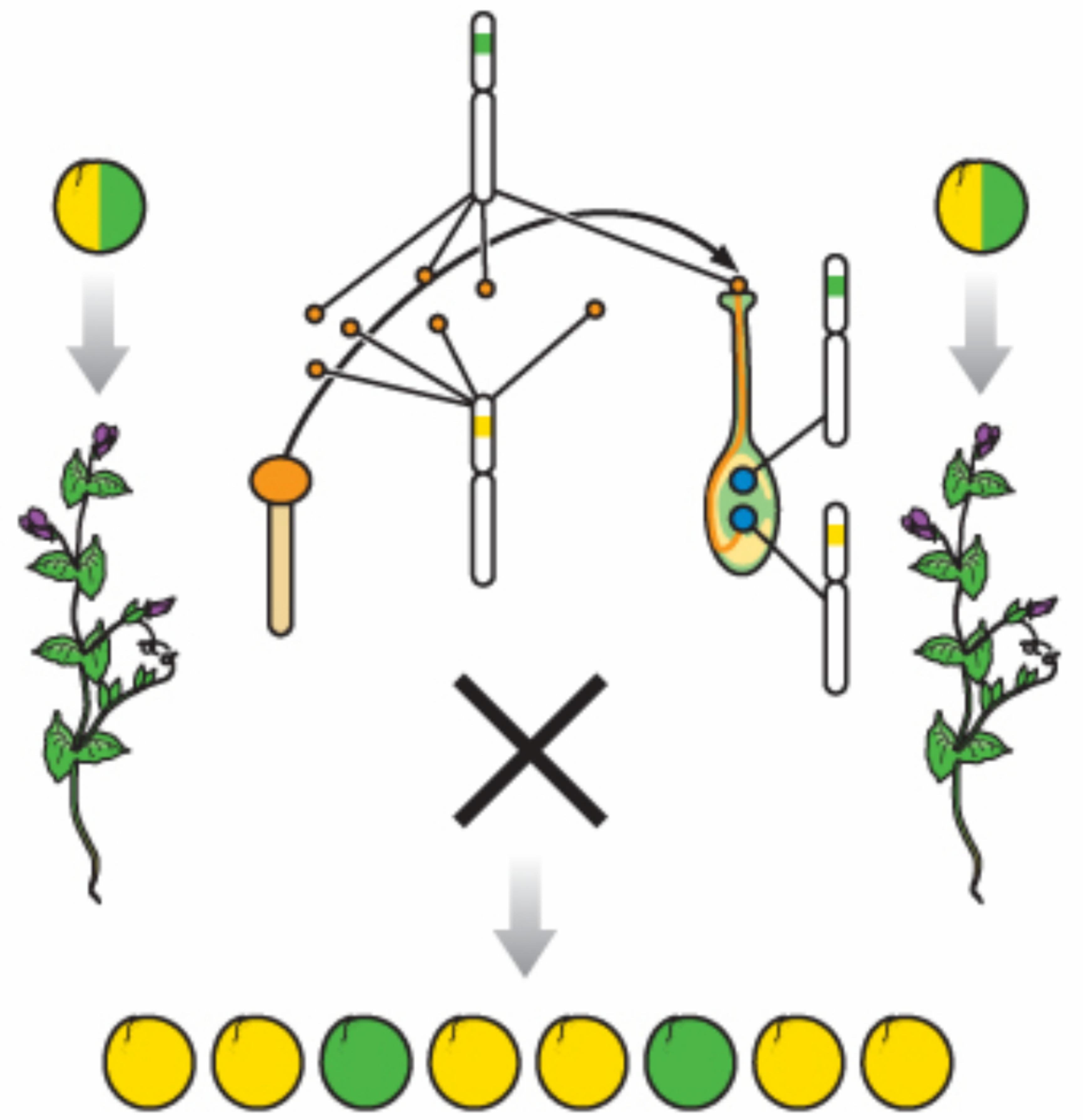


Figure 3.7 Chance events cause variations from the calculated ratio of 3:1. Whether a particular pollen grain will land on the stigma is random, as is the particular egg to be fertilized. Parental heterozygous peas are shaded half yellow and half green for illustration purposes but would appear fully yellow. Original art.

Versuche

über

Pflanzen-Hybriden,

von

Gregor Mendel.

(Separatabdruck aus dem IV. Bande der Verhandlungen des naturforschenden Vereines.)

Im Verlage des Vereines.

Brünn, 1866.

Aus Georg Gastl's Buchdruckerei, Postgasse Nr. 446.

Einleitende Bemerkungen.

Künstliche Befruchtungen, welche an Zierpflanzen desshalb vorgenommen wurden, um neue Farben-Varianten zu erzielen, waren die Veranlassung zu den Versuchen, die hier besprochen werden sollen. Die auffallende Regelmässigkeit, mit welcher dieselben Hybridformen immer wiederkehrten, so oft die Befruchtung zwischen gleichen Arten geschah, gab die Anregung zu weiteren Experimenten, deren Aufgabe es war, die Entwicklung der Hybriden in ihren Nachkommen zu verfolgen.

Dieser Aufgabe haben sorgfältige Beobachter, wie Kölreuter, Gärtner, Herbert, Lecocq, Wichura u. a. einen Theil ihres Lebens mit unermüdlicher Ausdauer geopfert. Namentlich hat Gärtner in seinem Werke „die Bastarderzeugung im Pflanzenreiche“ sehr schätzbare Beobachtungen niedergelegt, und in neuester Zeit wurden von Wichura gründliche Untersuchungen über die Bastarde der Weiden veröffentlicht. Wenn es noch nicht gelungen ist, ein allgemein giltiges Gesetz für die Bildung und Entwicklung der Hybriden aufzustellen, so kann das Niemanden Wunder nehmen, der den Umfang der Aufgabe kennt und die Schwierigkeiten zu würdigen weiss, mit denen Versuche dieser Art zu kämpfen haben. Eine endgiltige Entscheidung kann erst dann erfolgen, bis Detail-Versuche aus den verschiedensten Pflanzen-Familien vorliegen. Wer die Ar-

How to use: Punnett Square

Fig. 3.8

Punnett Square

Yy × Yy

1. define parental genotypes

Fig. 3.8

Punnett Square

pollen	Yy × Yy	
genotypes	maternal gamete genotypes	
	Y	y
Y		
y		

2. define gamete genotypes

Fig. 3.8

Punnett Square

pollen	Yy × Yy	
genotypes	maternal gamete genotypes	
	Y	y
Y	YY	Yy
y	Yy	yy

3. make all genotype combinations

Fig. 3.8

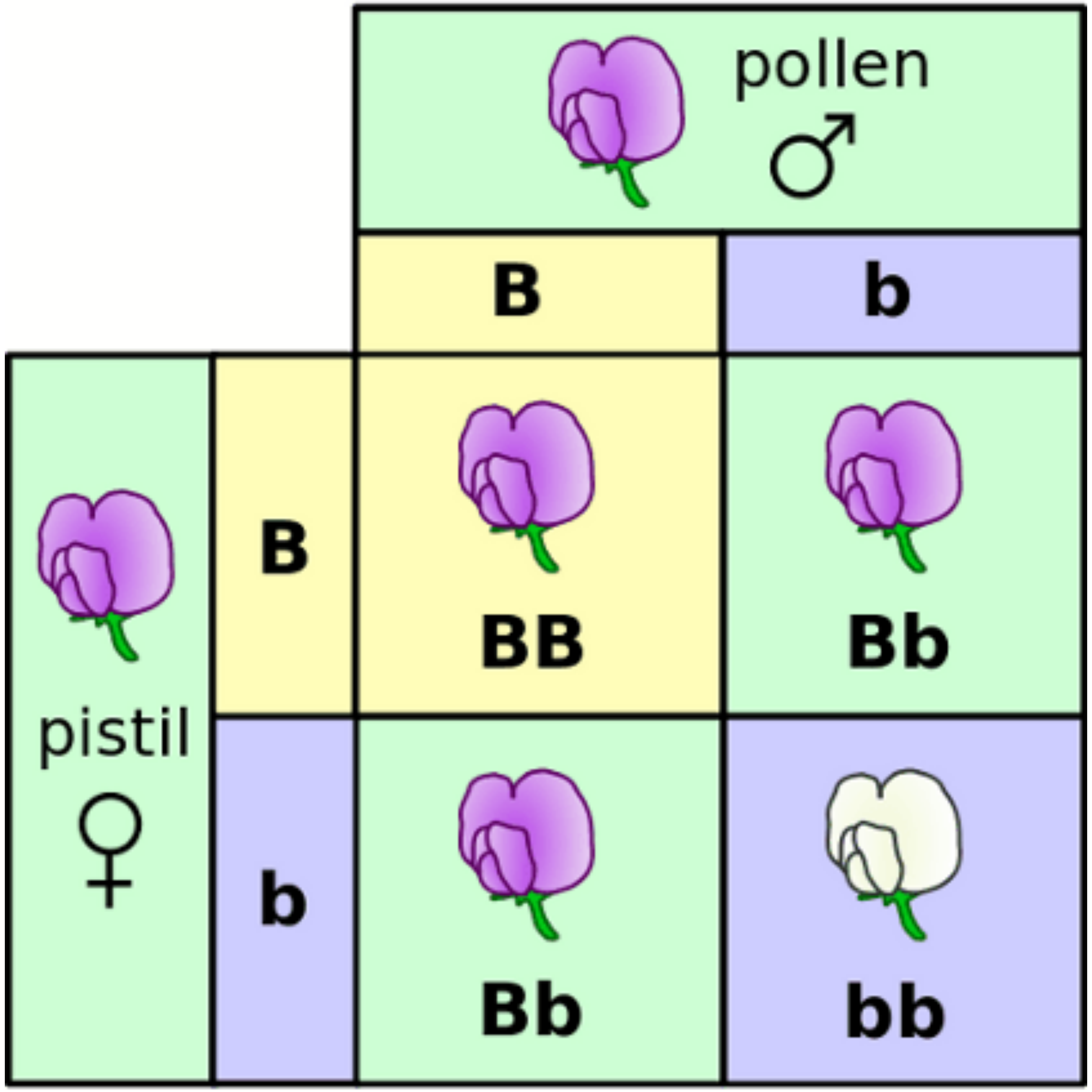
Punnett Square

pollen	Yy × Yy	
genotypes	maternal gamete genotypes	
	Y	y
Y	YY	Yy
y	Yy	yy

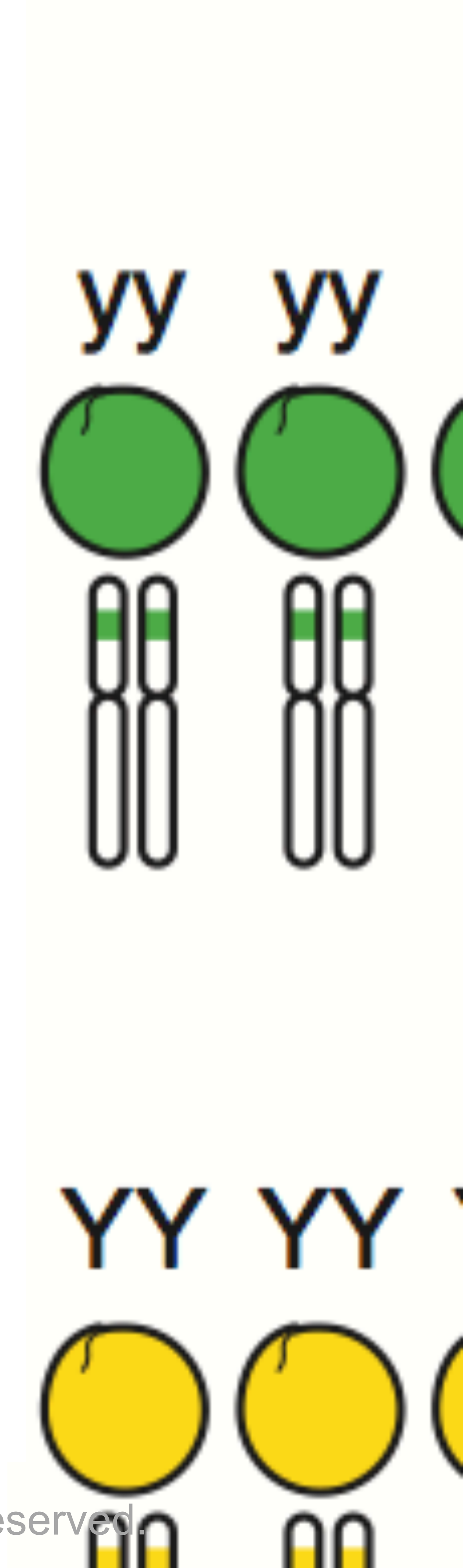
4. deduce phenotypes

Fig. 3.8

What does **dominant** mean? Why/how?



What's the GENOTYPE?



What’s the GENOTYPE?

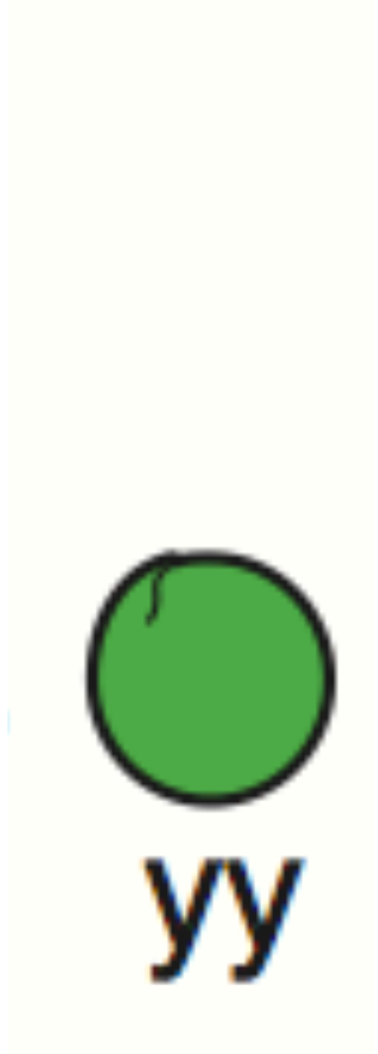
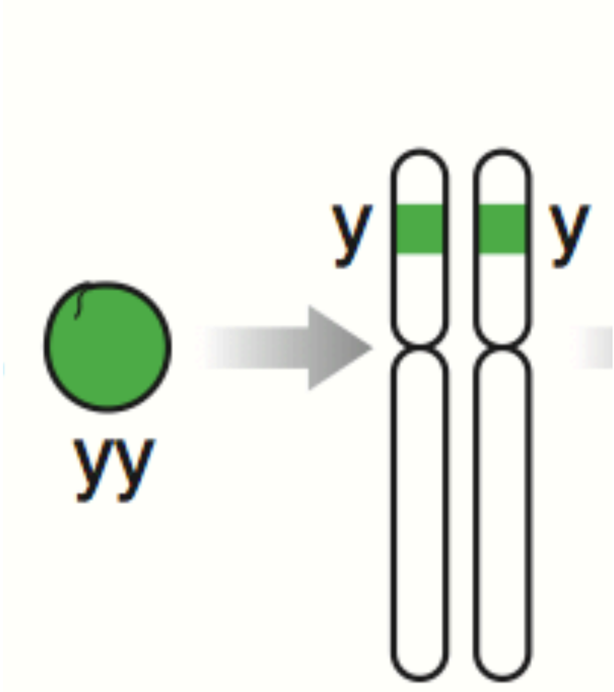


Fig. 3.6

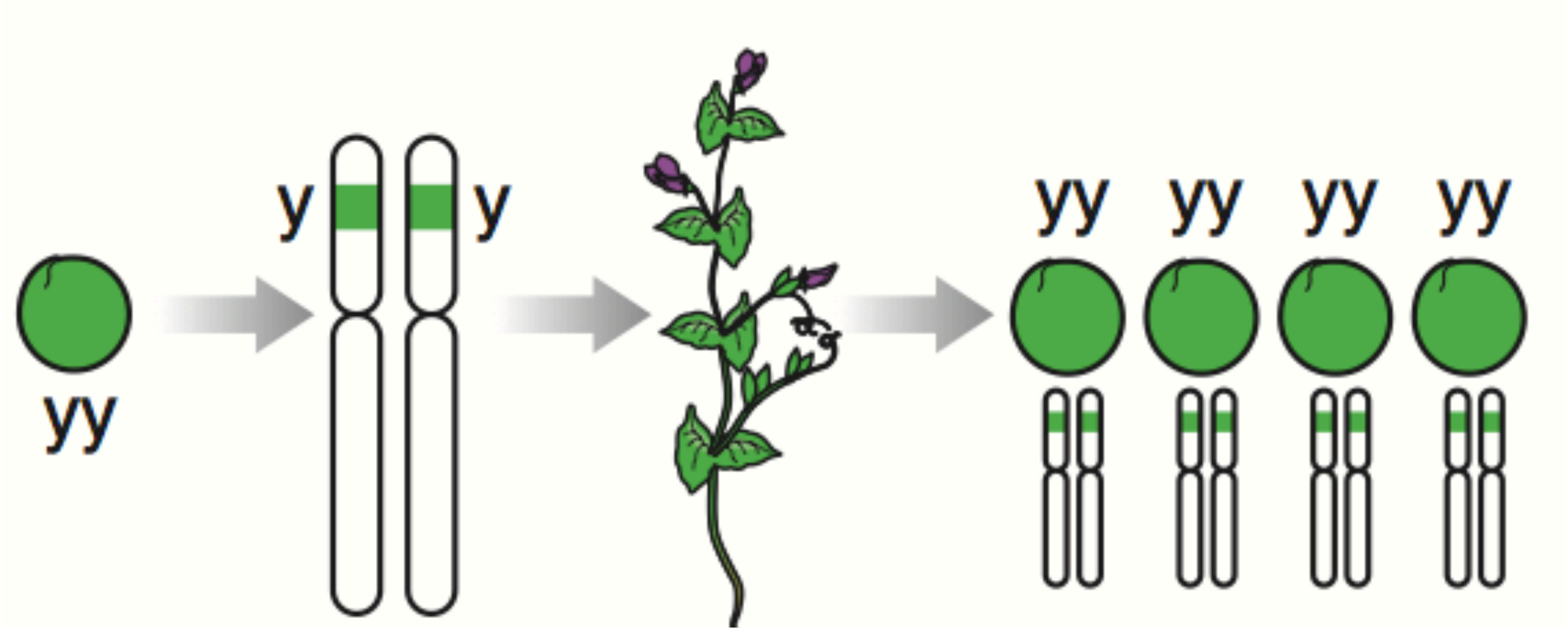
What's the GENOTYPE?



homozygous
recessive trait

Fig. 3.6

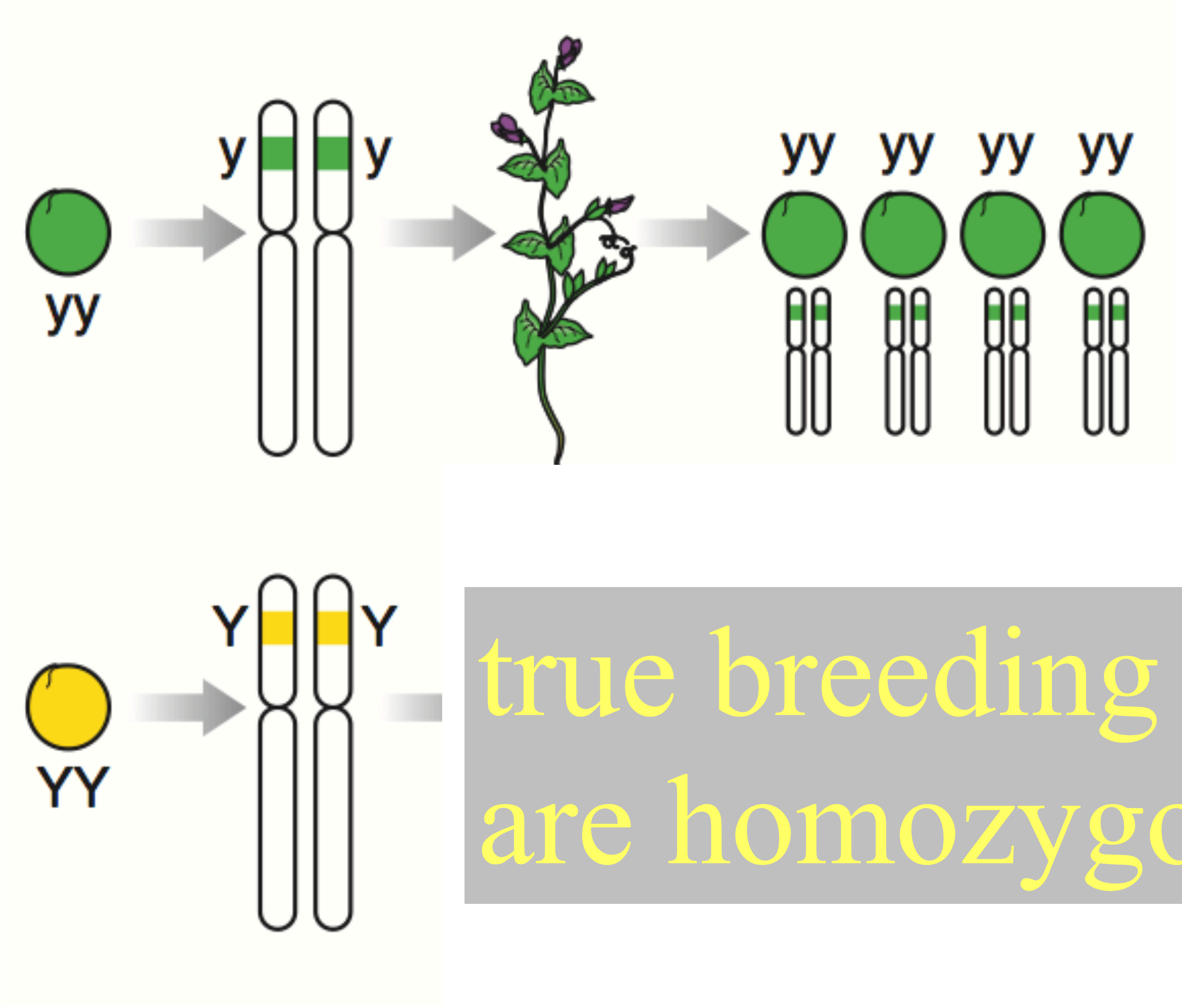
What's the GENOTYPE?



F_2 plants produce only *y* alleles and green peas

Fig. 3.6

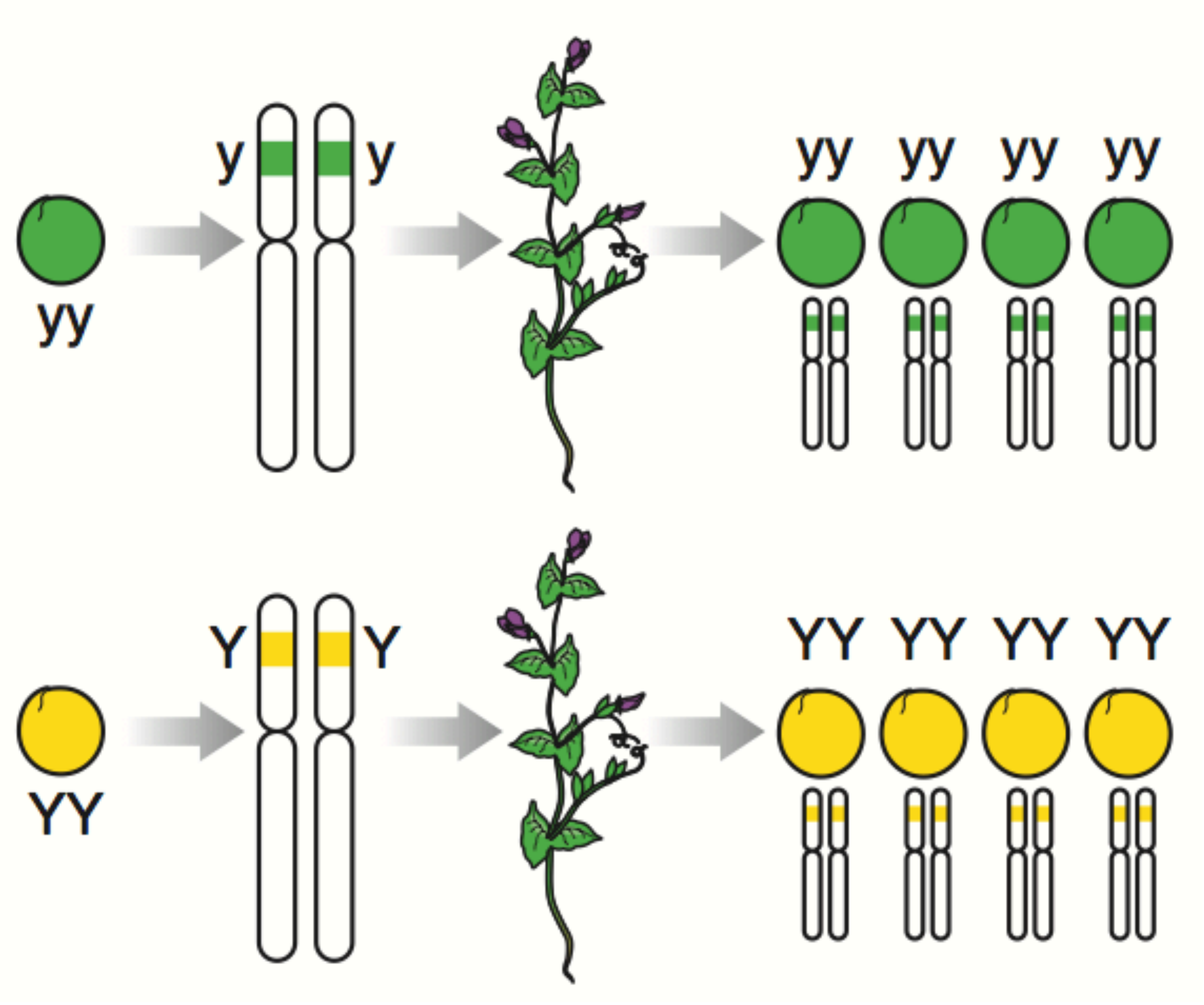
What's the GENOTYPE?



true breeding yellow
are homozygous *Y*

Fig. 3.6

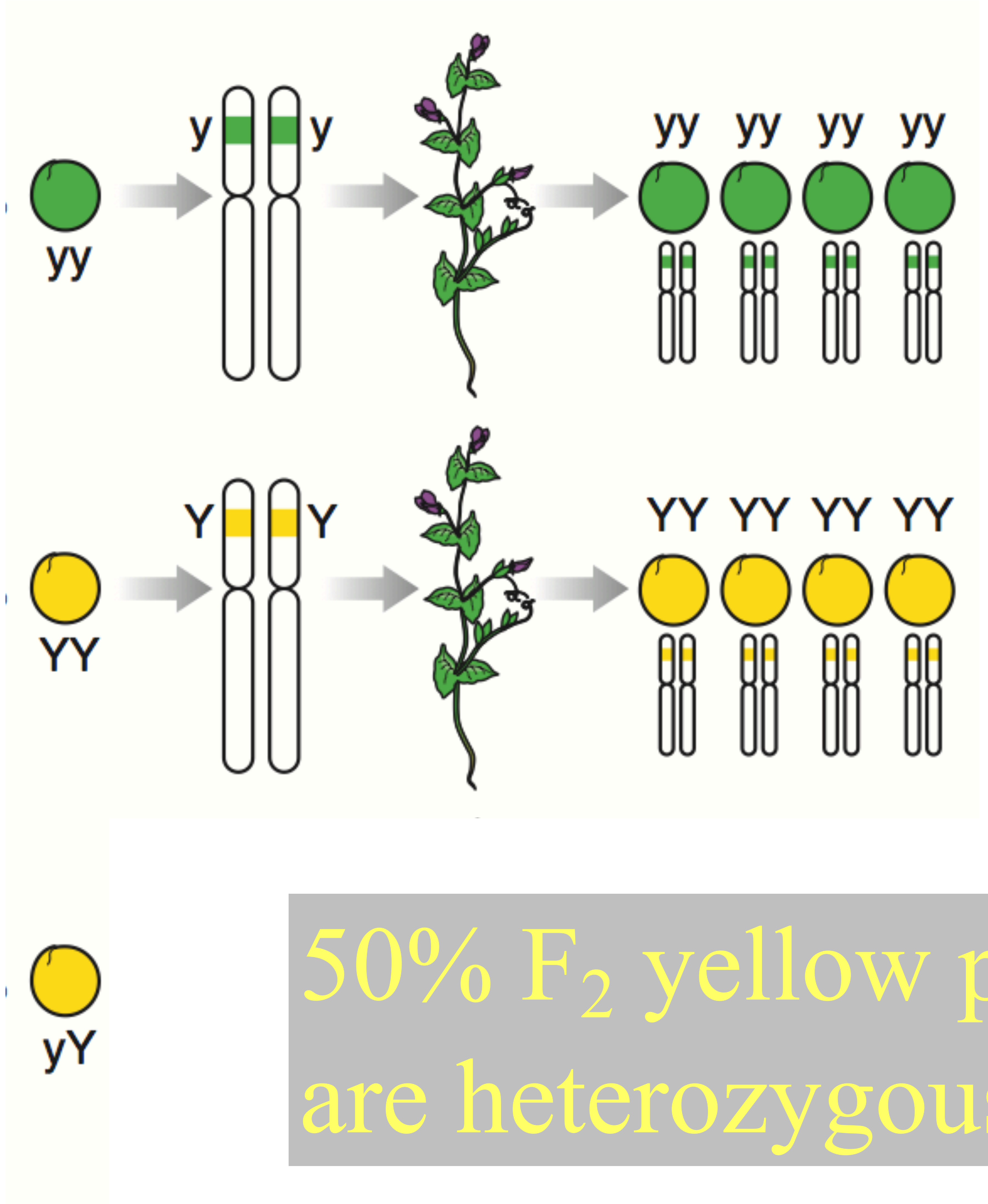
What's the GENOTYPE?



true breeding produce only
Y alleles and yellow peas

Fig. 3.6

What's the GENOTYPE?



50% F_2 yellow peas are heterozygous

Fig. 3.6

What’s the GENOTYPE?

heterozygous plants
produce 3:1 peas

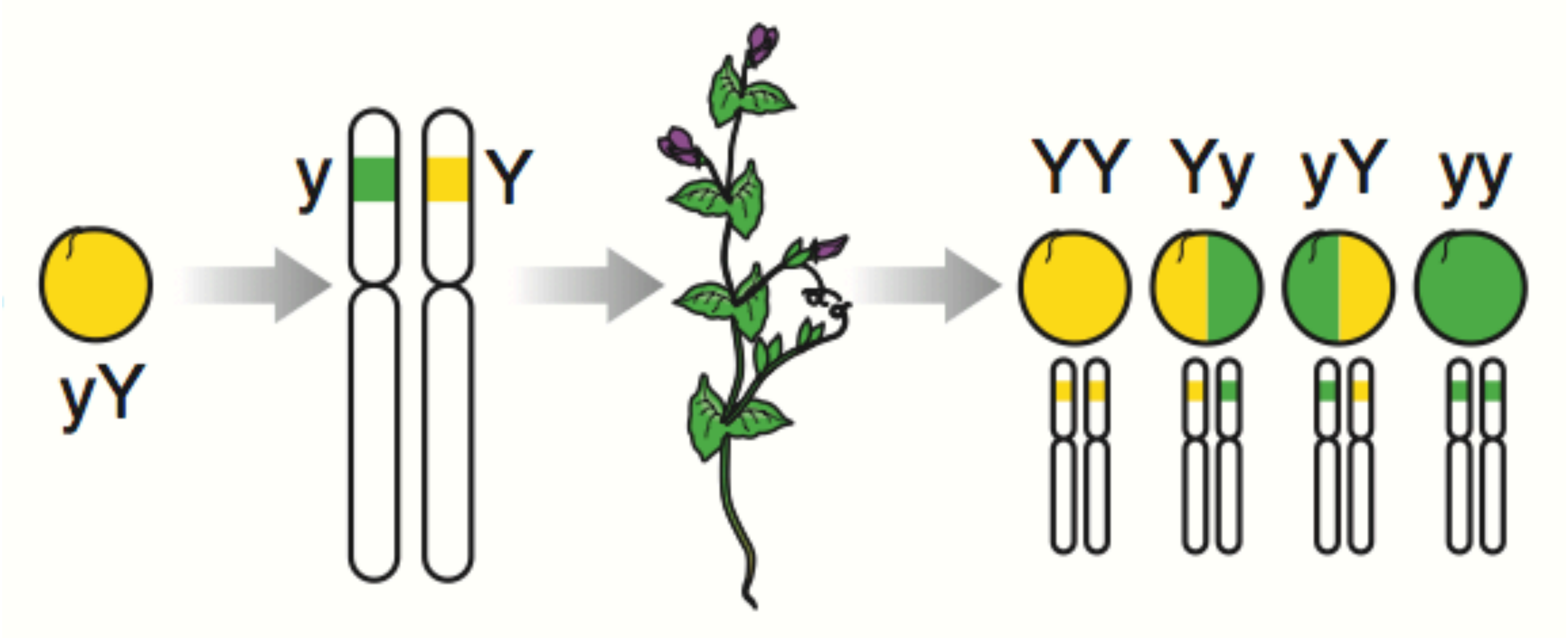


Fig. 3.6

What's the GENOTYPE?

mix of all 4 genotypes

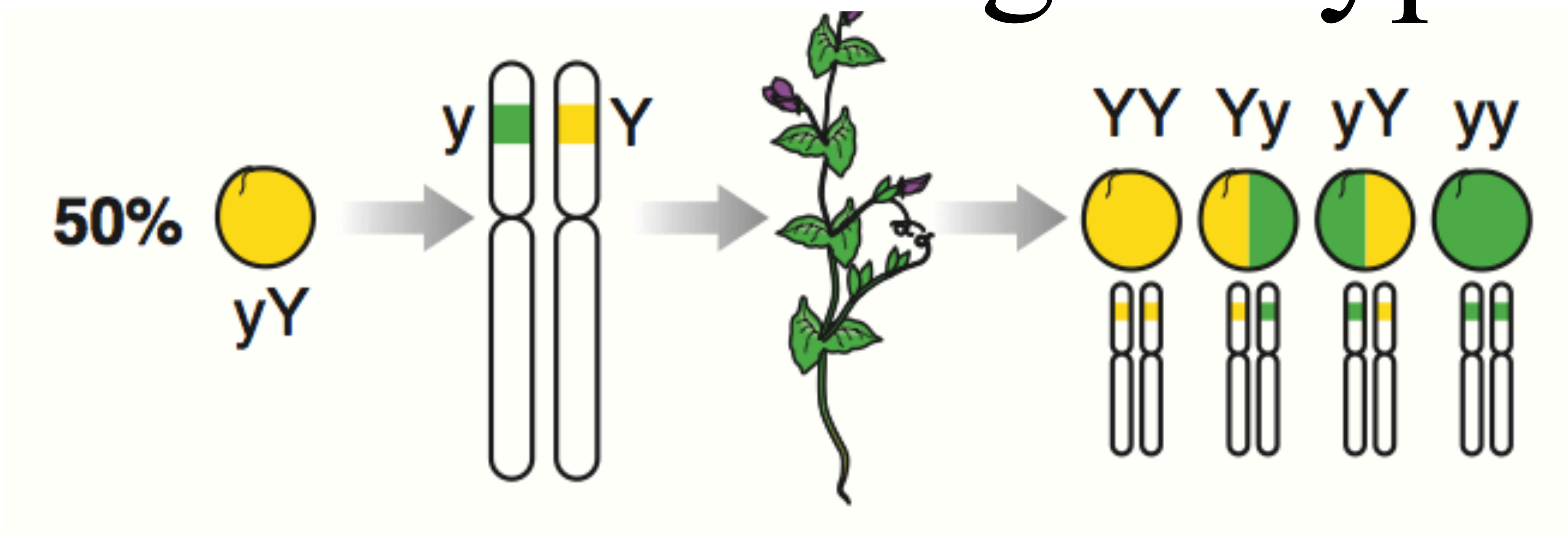


Fig. 3.6

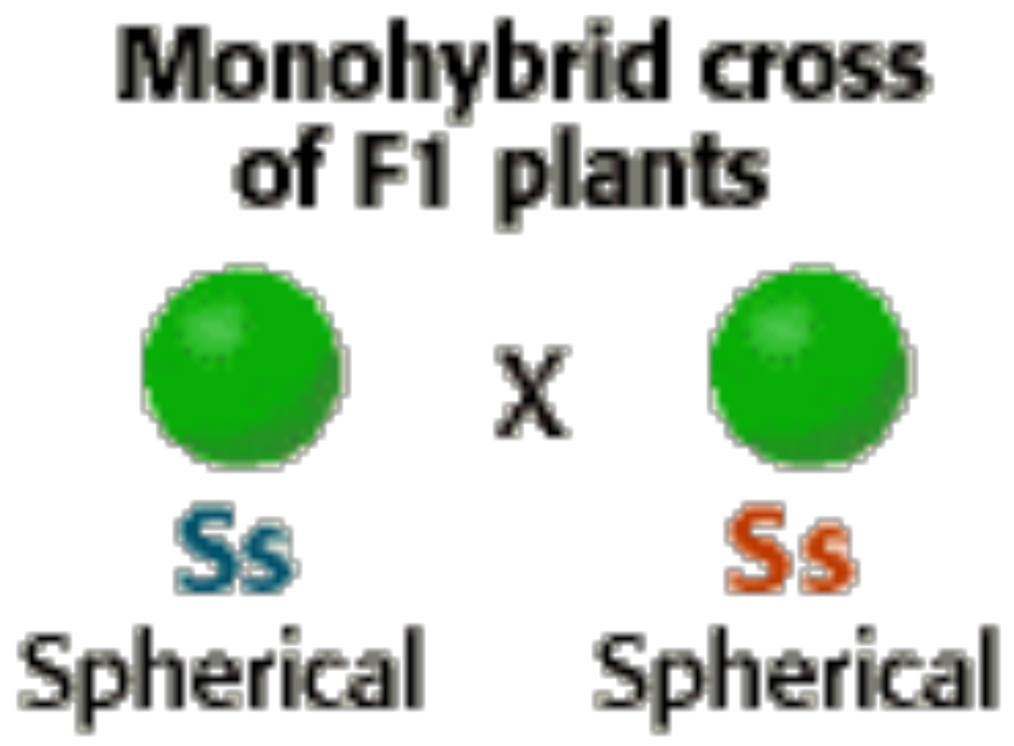
“Welcome to Mars”
LB144-Pandemic edition

Alternative versions of individual genes are called _________.

A. gametes
B. alleles
C. loci
D. homozygous

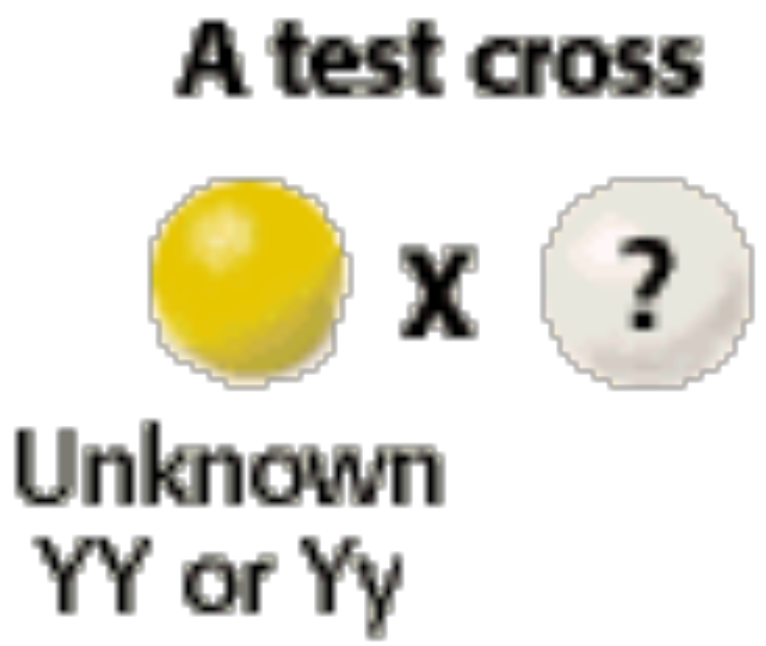
F2?: In pea plants, spherical seeds (S) are dominant to dented seeds (s). In a genetic cross of two plants that are heterozygous for the seed shape trait, what fraction of the offspring should have spherical seeds?

A. None
B. 1/4
C. 1/2
D. 3/4
E. All



Test Cross: To identify the genotype of yellow-seeded pea plants as either homozygous dominant (YY) or heterozygous (Yy), you could do a test cross with plants of genotype _______.

A. y
B. Y
C. yy
D. YY
E. Yy



A cross between a black mouse and a brown mouse produced 4 black offspring and 4 brown offspring. Black coat color is dominant to brown coat color, and therefore you can conclude that _________.

A. the black parent was homozygous
B. both parents are homozygous
C. the brown parent was heterozygous
D. the black parent was heterozygous

extra credit: Which is one of Mendel's two fundamental rules of inheritance?

A. Independent Crossover
B. Independent Assortment
C. Independent Segregation
D. Independent Recombination
E. More than one of the above
F. None of the above