Genetics in the news

[The strawberry genome: a complicated past and promising future | Horticulture Research]

Within the juicy red flesh of the commercial strawberry lies a deep history that spans at least three continents and hundreds of thousands of years. The genetic heritage of this prized dessert fruit was crafted by nature, with its modern improvement driven by the indigenous Mapuche people of South America, a seafaring a French spy, and a plant-loving teenager that gathered fruits to present to a king. The many stories that punctuate the history of the modern strawberry relate to its contemporary cultivation as well as origins that span a significant portion of the globe[1,2]. The evidence of this rich history is locked away within the chromosomes of every cell, each archiving a complicated story that speaks both of strawberry's historical origins and genetic potential for future production.

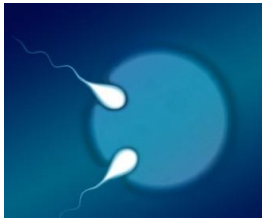
The complete genetic storybook of the commercial strawberry has remained a secret to researchers, until now.

Genetics in the news

This Mutant Crayfish Clones Itself, and It's Taking Over Europe

Triploid

- Therefore larger in size
- Possibly caused by dispermy in crowded "petshop" aquarium



- Parthenogenic
- Can reproduce without mating

$p = 1 \times 1/2 \times 1/2$

$p = (1/2)^{n-1}$

quick correction from last time

The Molecular Basis of Inheritance

From Chromosomes to Genomes

BIOL 202

Prof. Laura Nilson, Dept of Biology

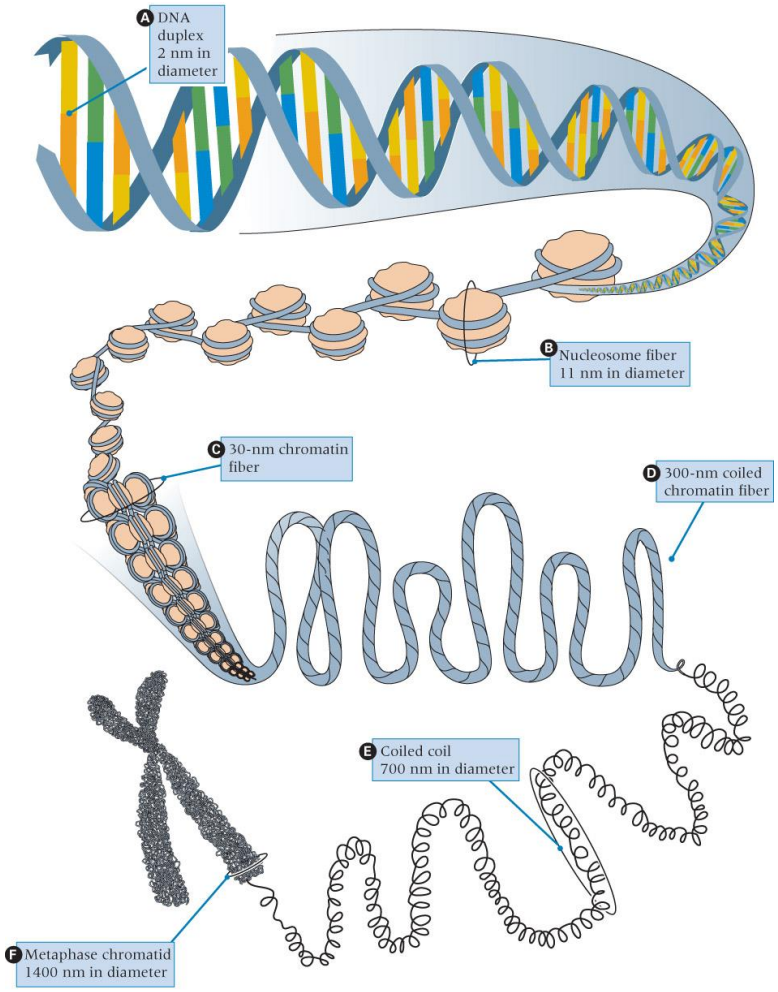
Office hours

- Fridays 1-2pm (zoom or Stewart Biology, N5/8)

https://mcgill.zoom.us/j/81407275167?pwd=8Cgm0RPnWQRlOdaCNFyXnS3M8amQUj.1

- By appointment
- Before or after class, right here in Leacock 132

Here's an overview of this section



- Large scale changes in chromosome number or structure
- Transposable elements and genome surveillance
- DNA mutations: causes and consequences
- Understanding the genetic code: genetics, bioinformatics, and functional genomics

- Your input: Other topics of interest???

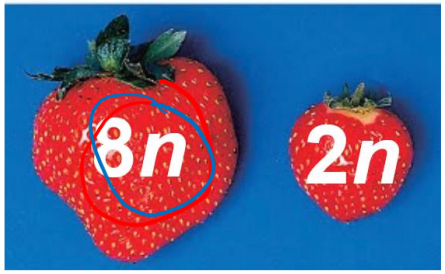
Autopolyploid

An individual that has multiple chromosome sets originating from within one species

Allopolyploid

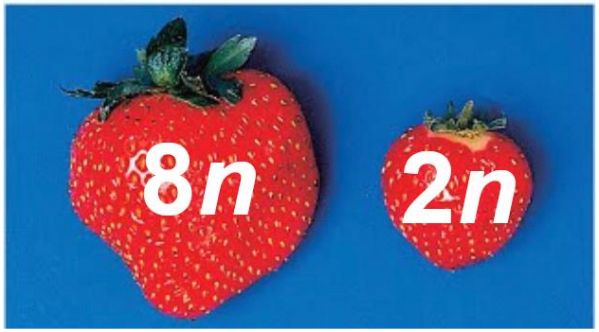
An individual that has multiple chromosome sets originating from two or more different species

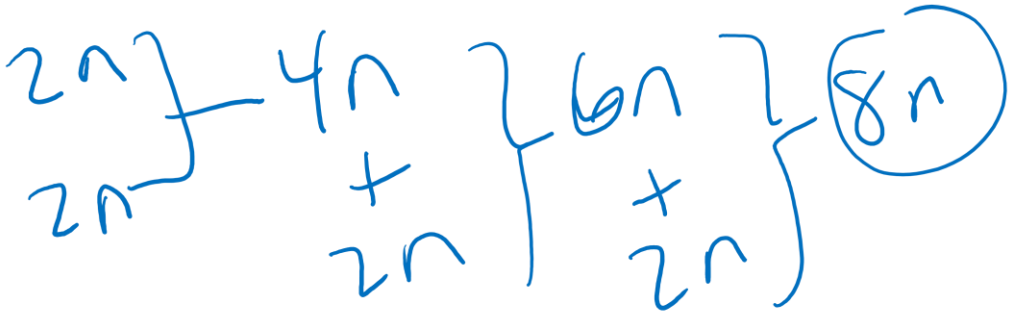
[The strawberry genome: a complicated past and promising future | Horticulture Research]



rutabega

Octoploid strawberry plants are allopolyploids that arose through natural sequential hybridization events involving different diploid strawberry species





[Strawberries Have 8 Sets of Chromosomes to Thank for Their Survival | Scientific American]

"In 2019, my colleagues and I published the first high-quality genome of the strawberry plant, which revealed the octoploid genome arose by a stepwise process. At some point over a million years ago, two ancient diploid species hybridized and produced a now-extinct plant species with four sets of chromosomes; that species hybridized with a third diploid species, resulting in six sets of chromosomes, and then with a fourth diploid species, resulting in eight sets of chromosomes. This ancient wild octoploid then spread throughout the Western Hemisphere, splitting into two species that European colonists collected in the 18th century; those plants underwent a final hybridization event in continental Europe around 300 years ago to create the strawberry you know and love in your grocery store or garden"

Origin of three allopolyploid species of *Brassica*

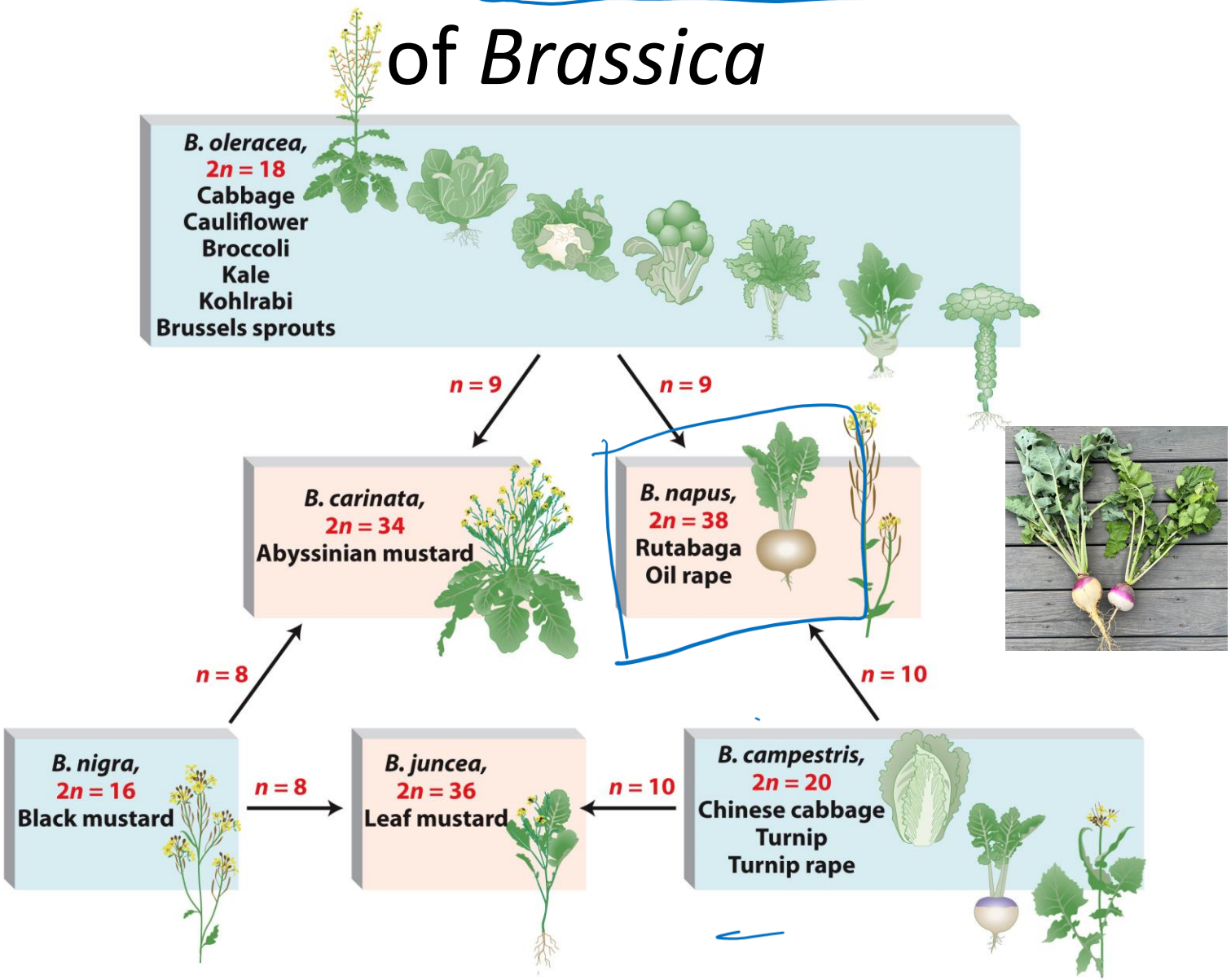
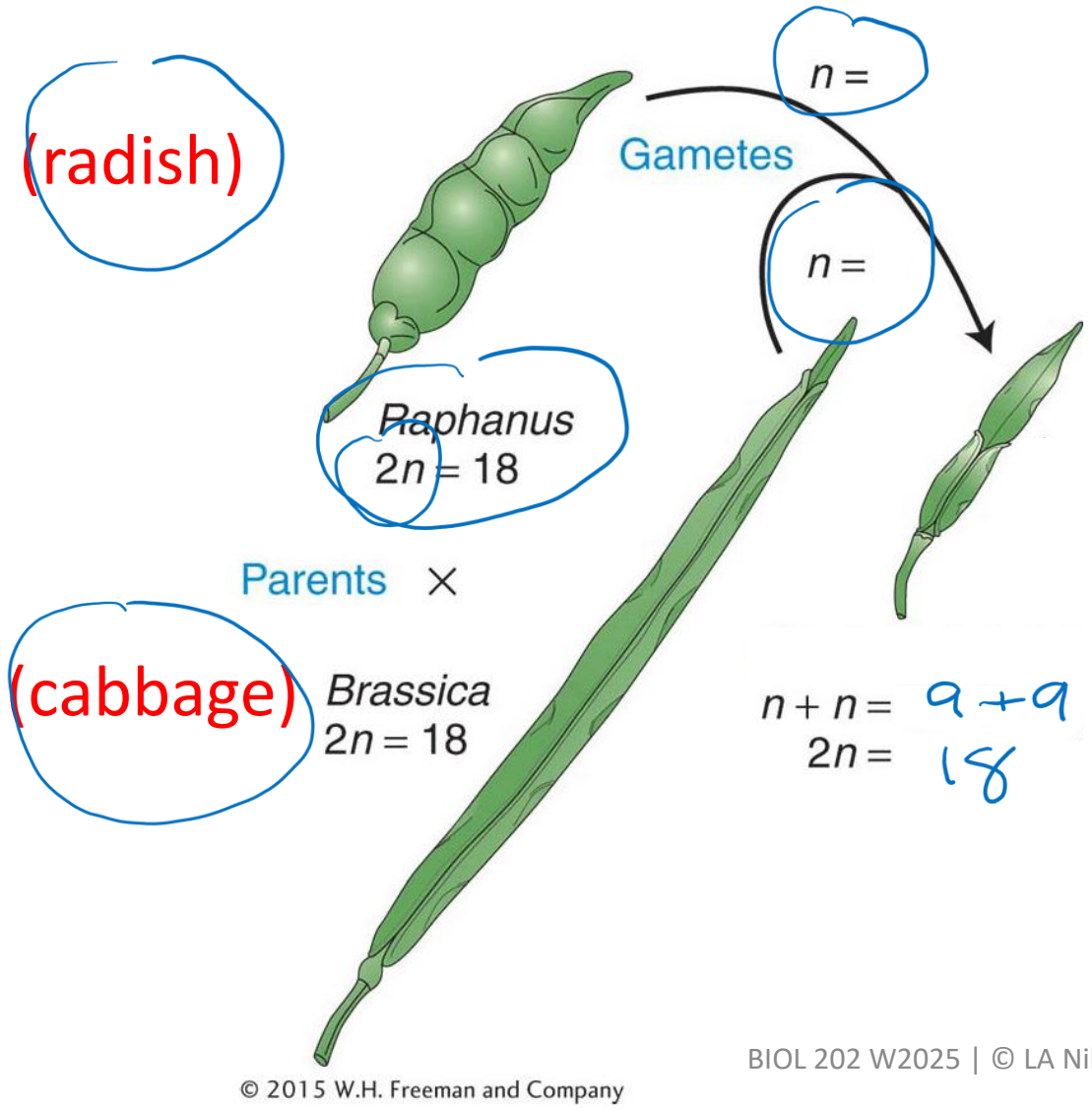
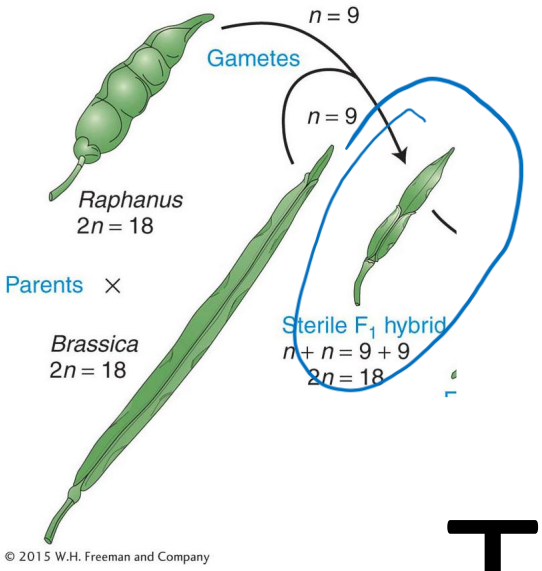


Figure 17-8
Introduction to Genetic Analysis, Eleventh Edition

Generation of an allopolyploid: a hybrid of two species





Think Break

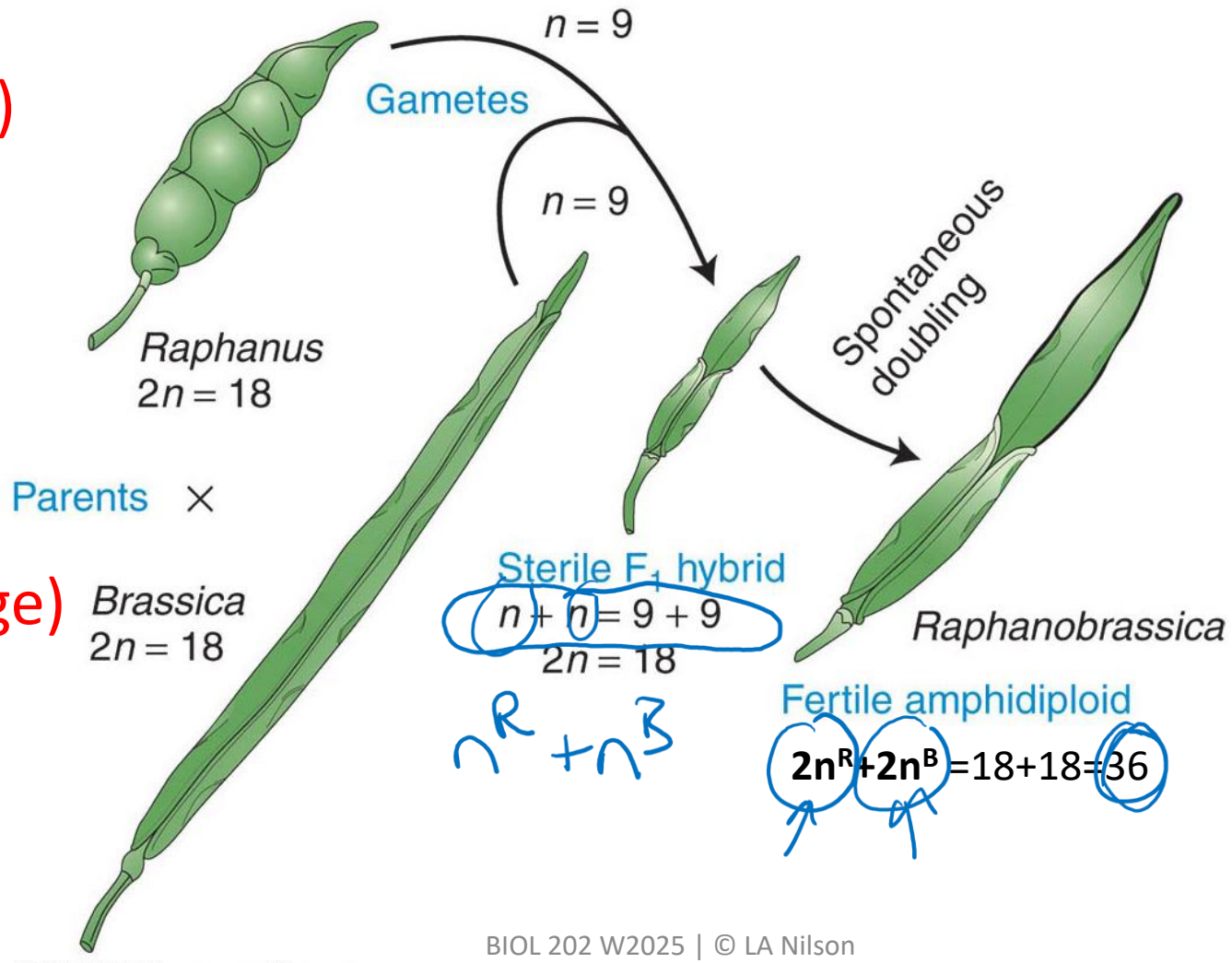
Why is this hybrid sterile?

because 2 sets are too different to pair during meiosis → defective seg. → aneuploid gametes

Generation of an allopolyploid

(radish)

(cabbage)



Crossing an allopolyploid back to one of its parent species

Raphanobrassica

Fertile amphidiploid

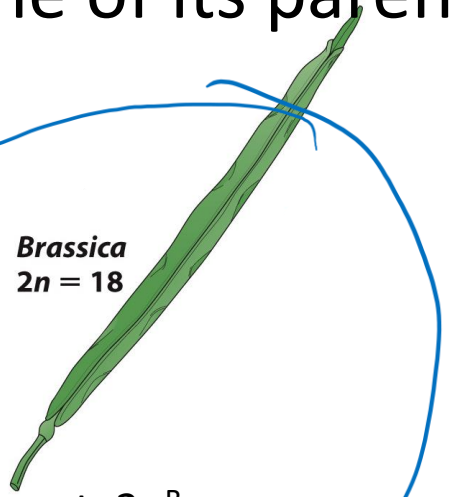
$2n + 2n = 18 + 18$

$4n = 36$

Parent: $2n^R + 2n^B$

Gametes: $n^R + n^B$

X



Brassica

$2n = 18$

Parent: $2n^B$

Gametes: n^B

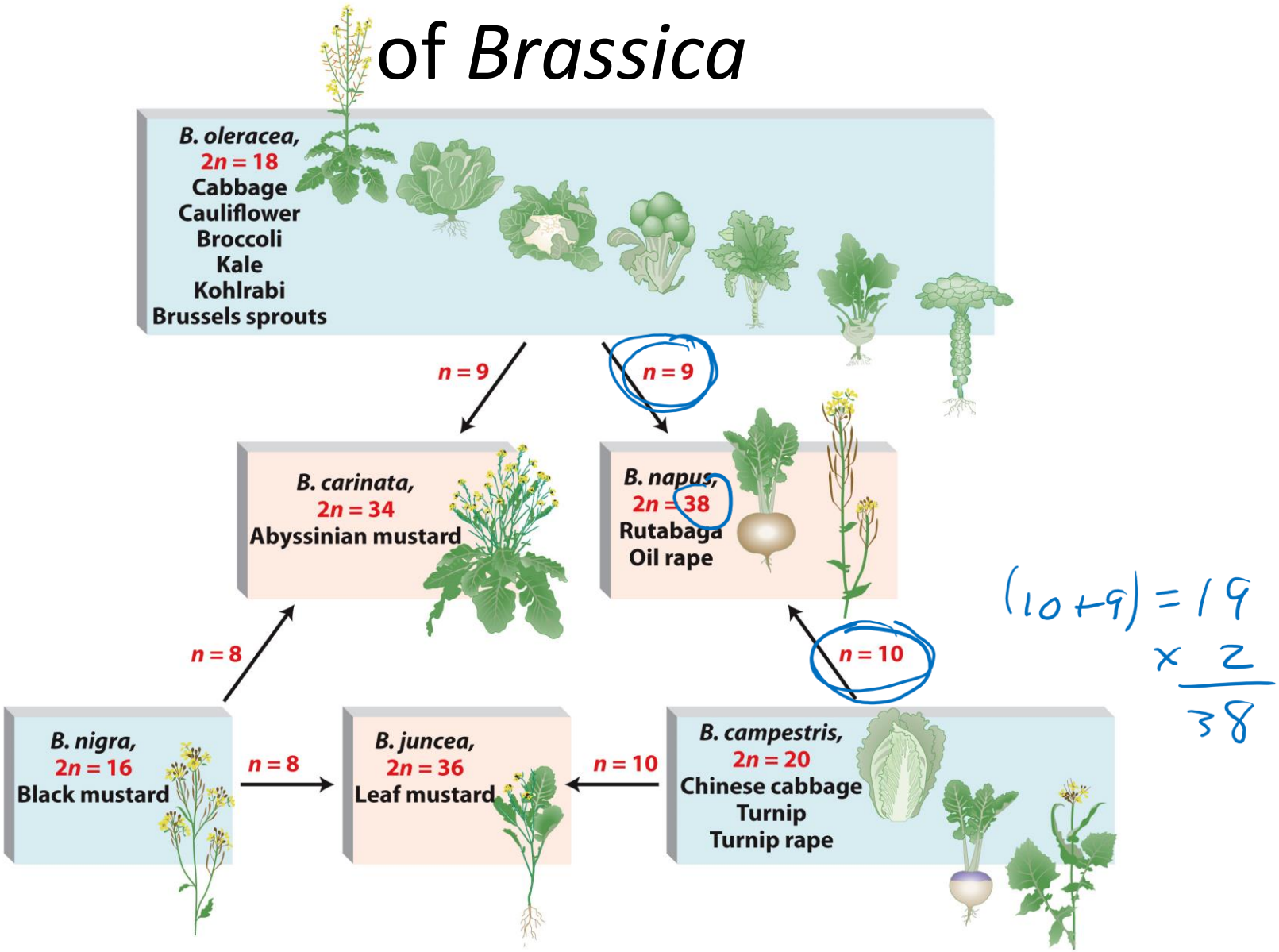
F1?

F1: $n^R + n^B + n^B$

F2?

Interpretation? These two plants can no longer breed with each other → new species

Origin of three allopolyploid species of *Brassica*



(10+9) = 19
× 2
38

Figure 17-8
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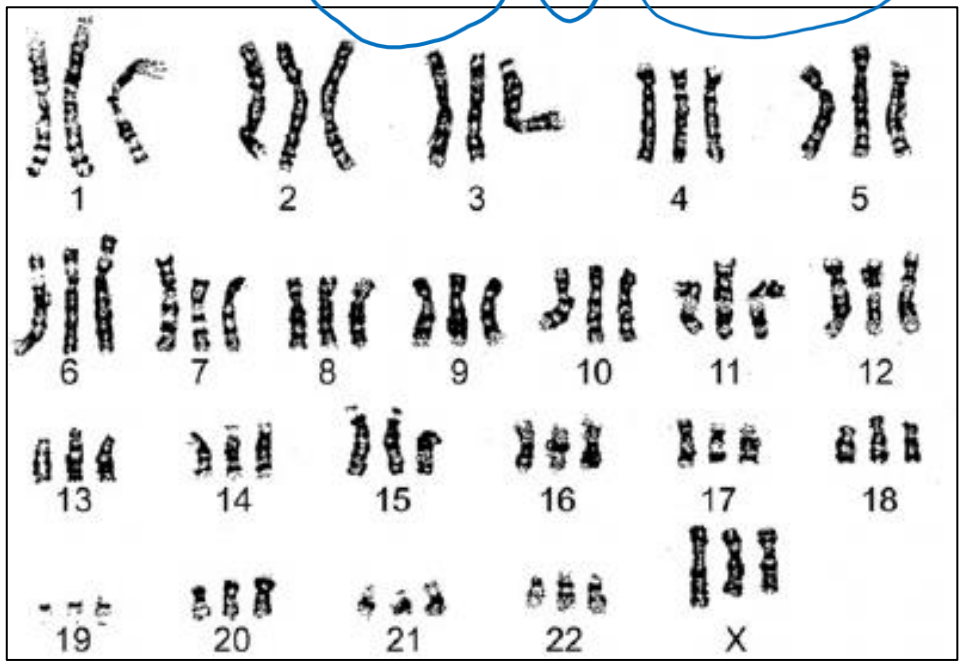
Large Scale Chromosomal Changes

Changes in Chromosome Number

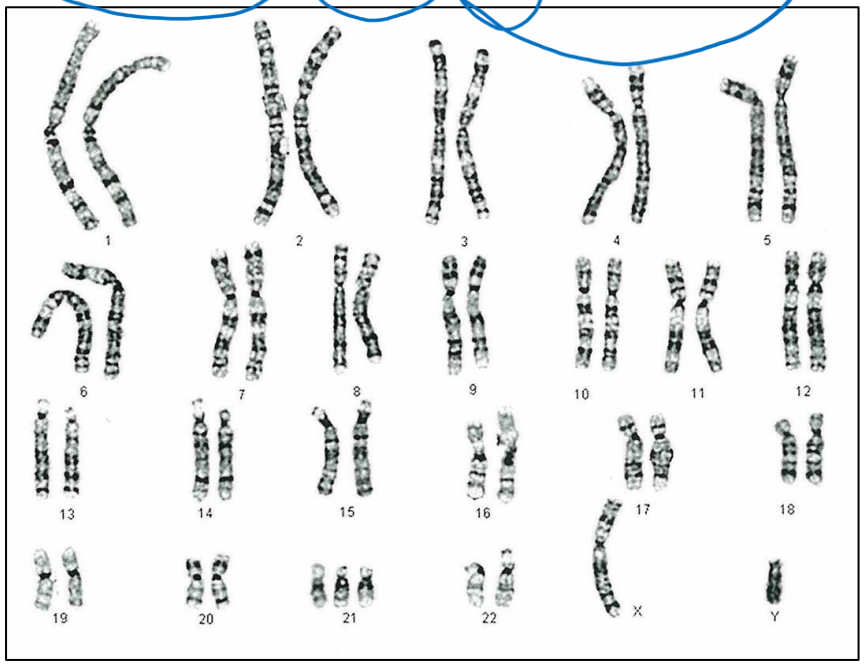
ANEUPLOIDY

Polyploidy vs. Aneuploidy

Polyploid ; triploid ; 3n (EUPLOID)



Trisomic ; 2n+1 (ANEUPLOID)



Effects on the soma
Effects on the germline
How does aneuploidy arise?

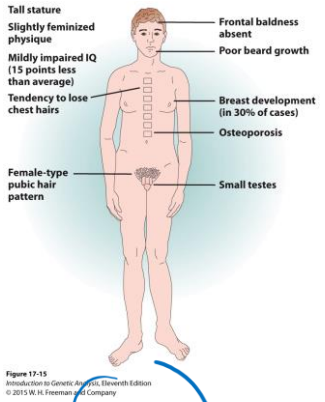
Trisomy

2n+1

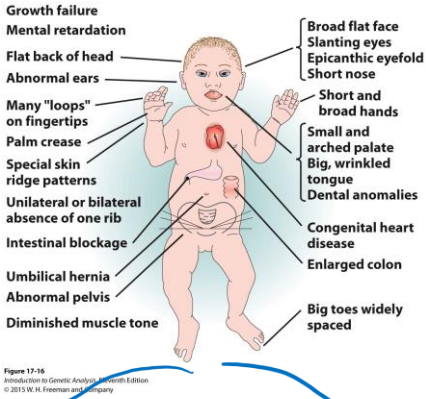
viable trisomies

XXX: normal

XYY: normal



XXY: Klinefelter syndrome



trisomy 21: Down syndrome

2n-1

viable monosomy

XO: Turner syndrome

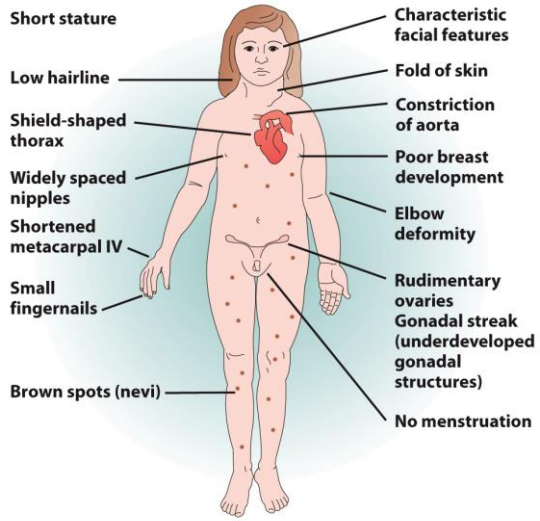


Figure 17-13
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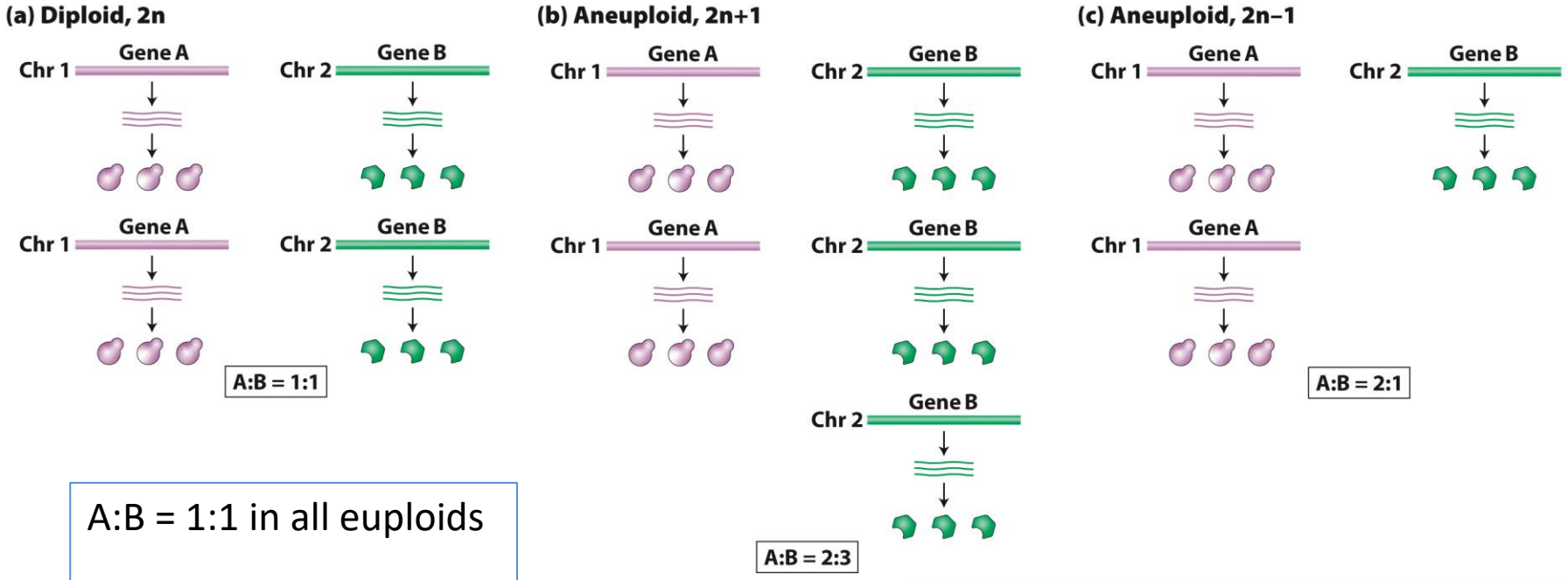
other trisomies

- Trisomy 13, Trisomy 18: non-viable, usually die in infancy
- All others: non-viable, die in utero

Aneuploidy affects the balance of gene dosage in a cell



A:B = 1:1 in all euploids

e.g. triploid = 3:3 = 1:1

Figure 17-17
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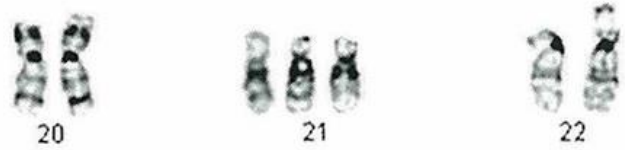


Human trisomy 21:

- Only trisomy to routinely survive to adulthood
- Phenotypes of partial trisomy 21s help identify which regions contribute to Down Syndrome

The trisomics of *Datura* (Jimsonweed)

n = 12

2n x 3n

↓

individual trisomics

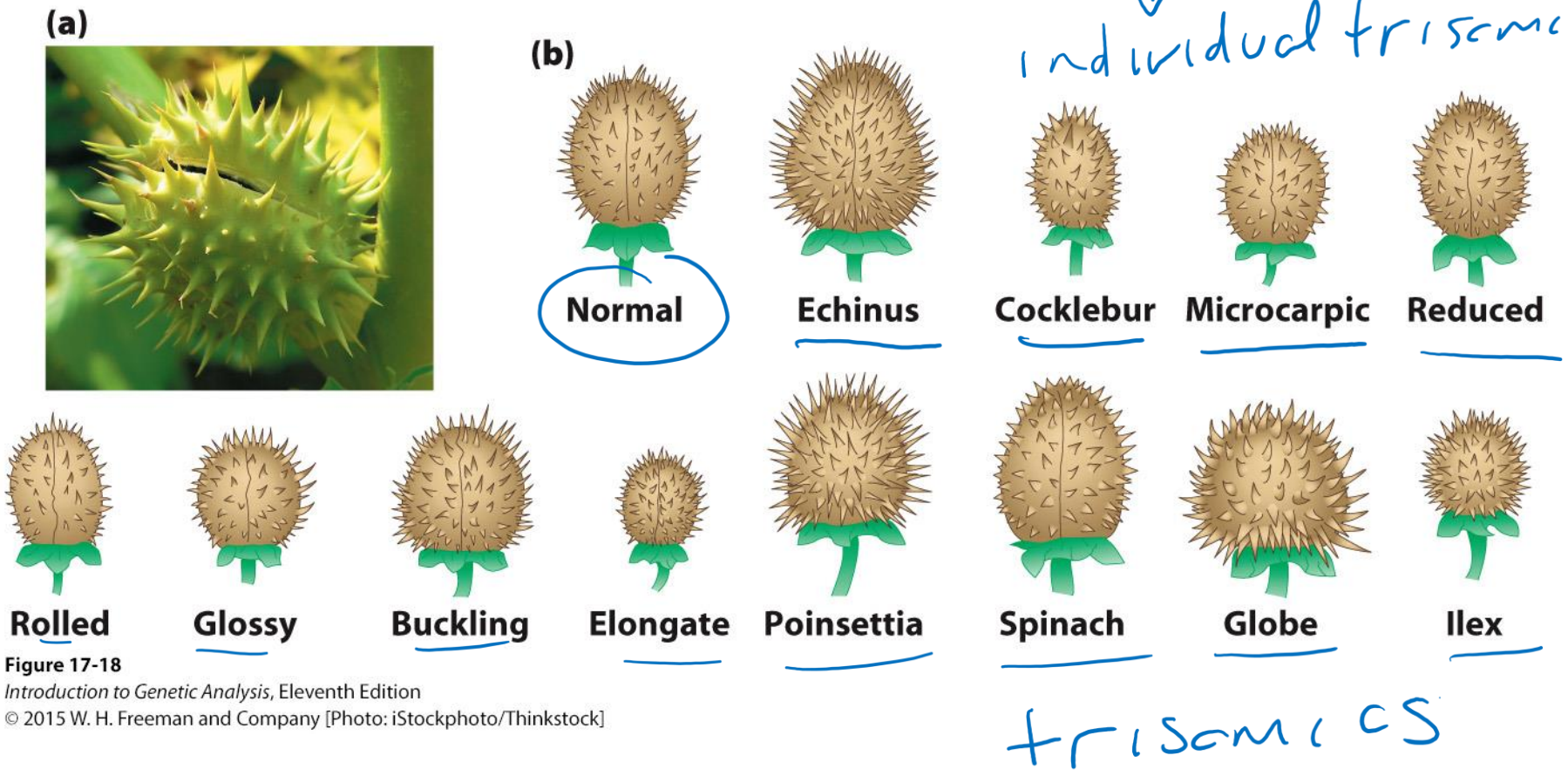


Figure 17-18
Introduction to Genetic Analysis, Eleventh Edition

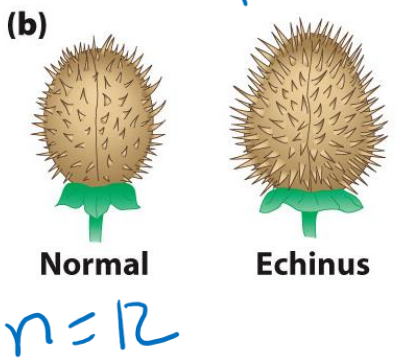
trisomics

n=12
2n=24
2n+1=25

Think Break

For a normal jimsonweed leaf cell, n=12. How many chromosomes are in the leaf cells of the trisomic Echinus variant?

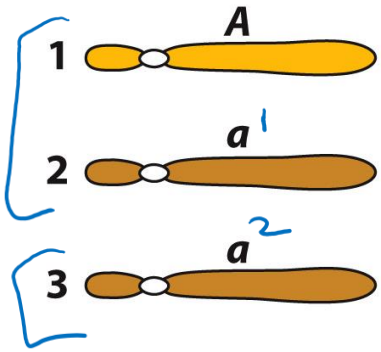
trisomic



n=12

Germline consequences of aneuploidy

Meiotic products of a trisomic



3 possible configurations in meiosis I

3 possible meiosis outcomes = 6 possible gametes

One pole	Other pole
A (1), a (2)	a (3)
A (1), a (3)	a (2)
a (2), a (3)	A (1)

Figure 17-14
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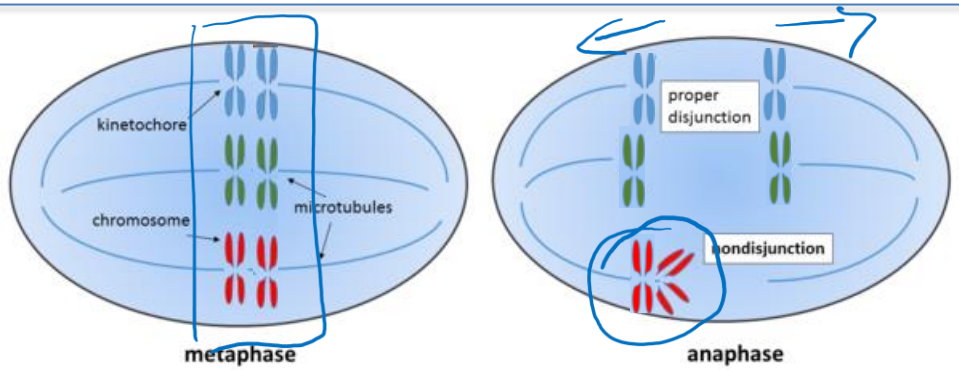
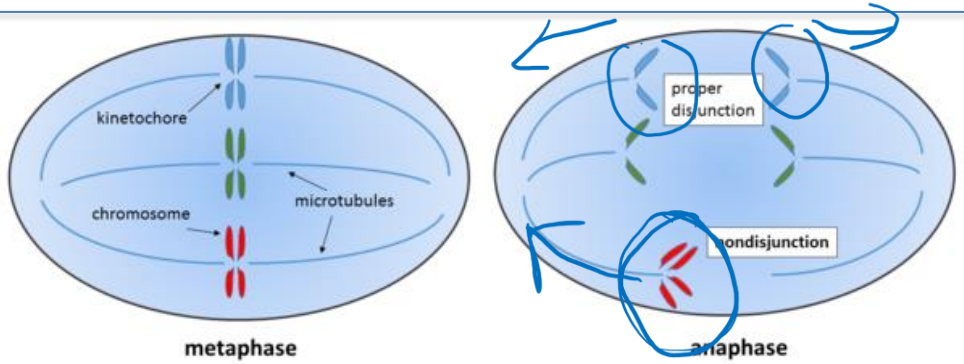
How does aneuploidy arise?

Aneuploidy can result from “non-disjunction” of homologous chromosomes during meiosis in diploid individuals

Meiosis I



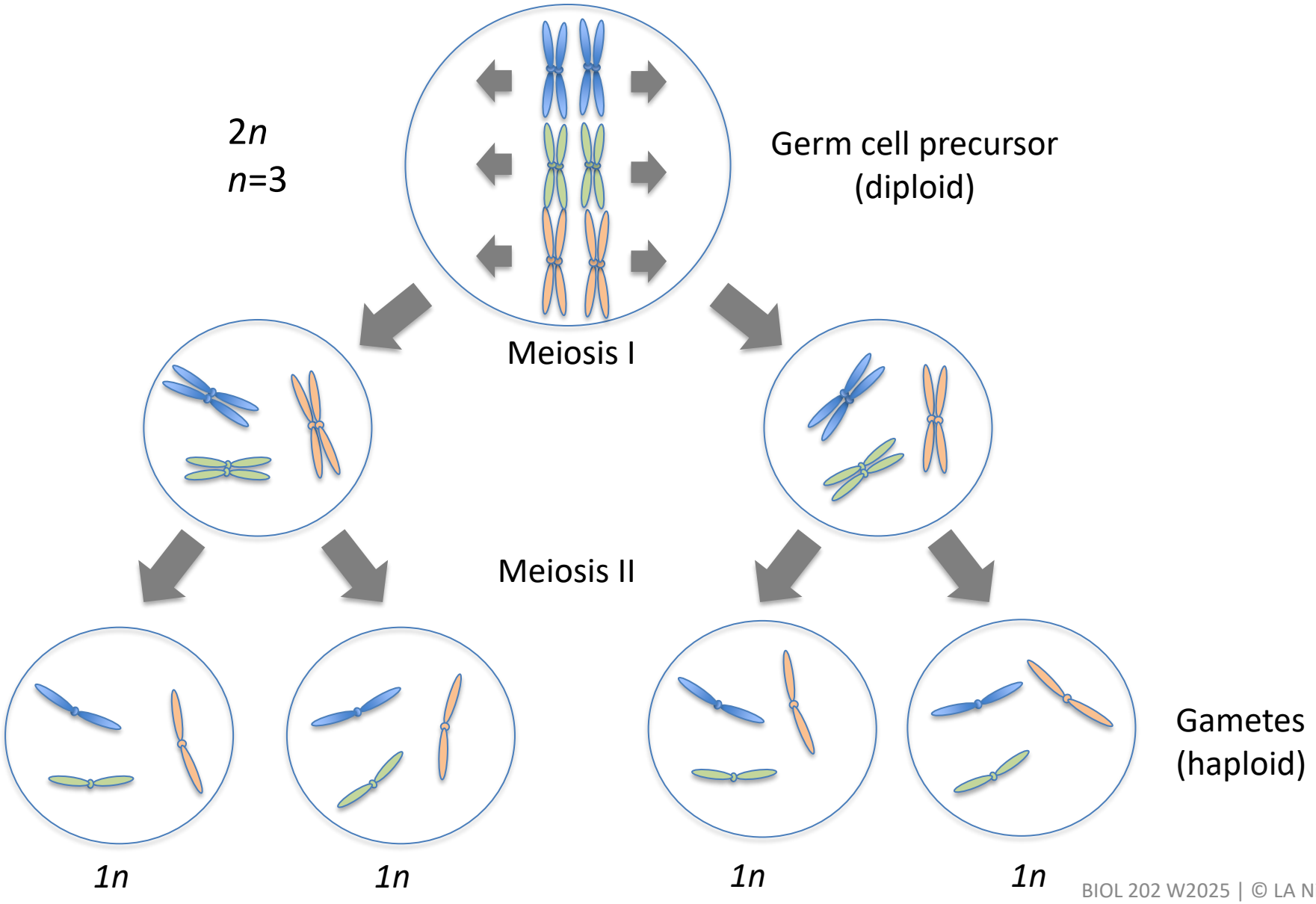
Meiosis 2



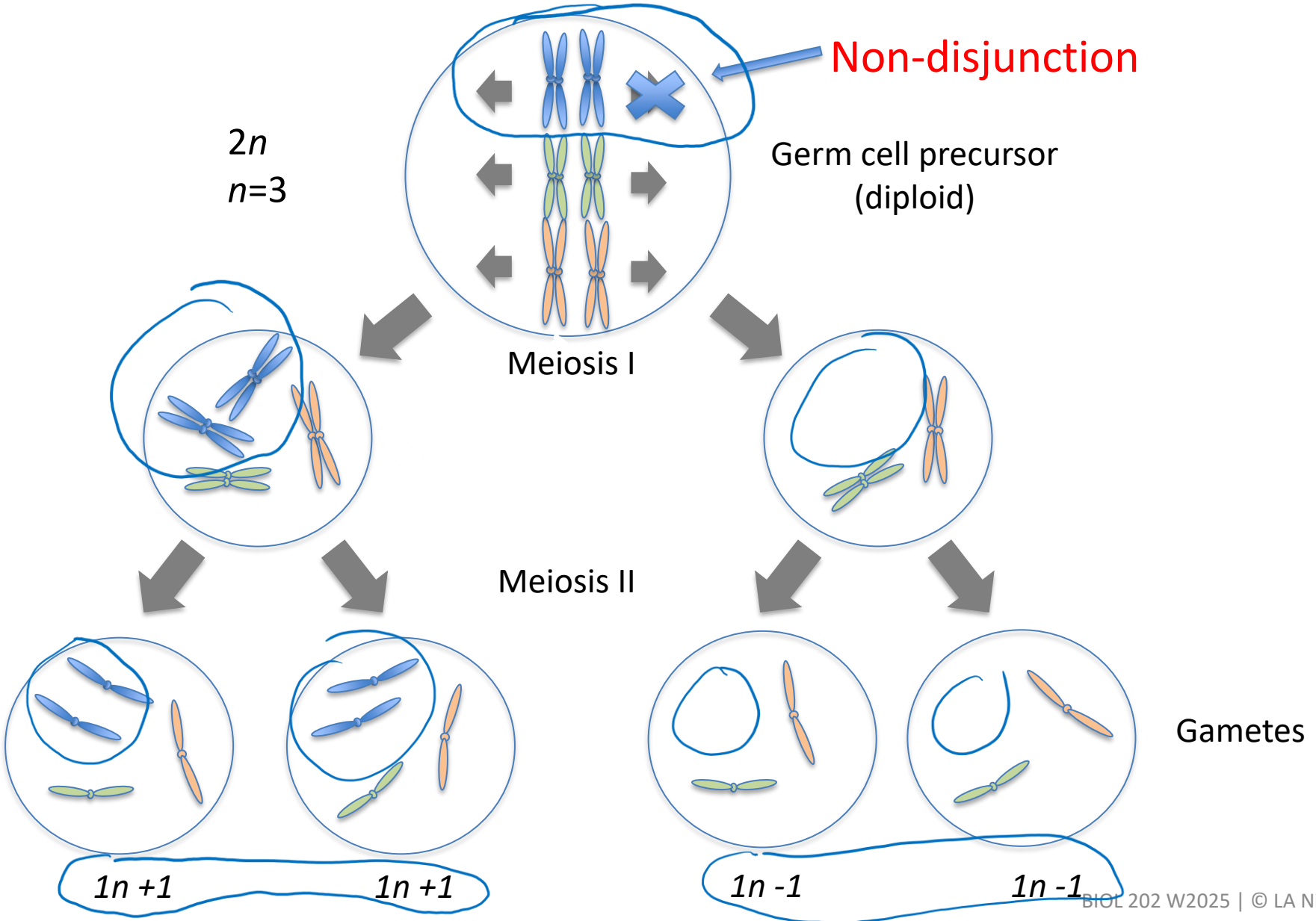
Can also happen during mitosis

Nondisjunction occurs spontaneously. It is an example of a chance failure of a basic cellular process.

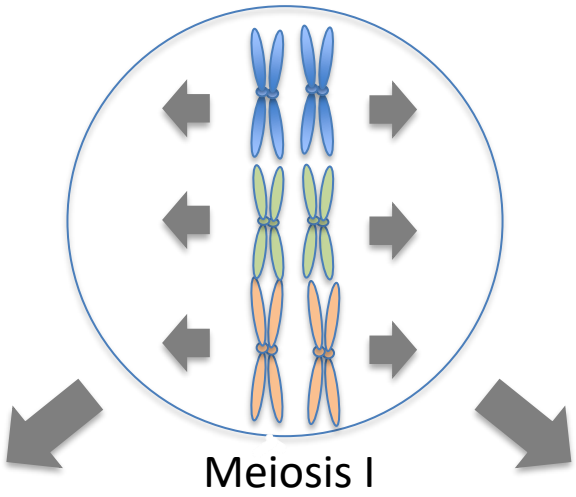
Normal meiosis in diploids



Non-disjunction during meiosis 1: 100% aneuploid gametes



Nondisjunction in meiosis I can reflect a failure in pairing/crossovers



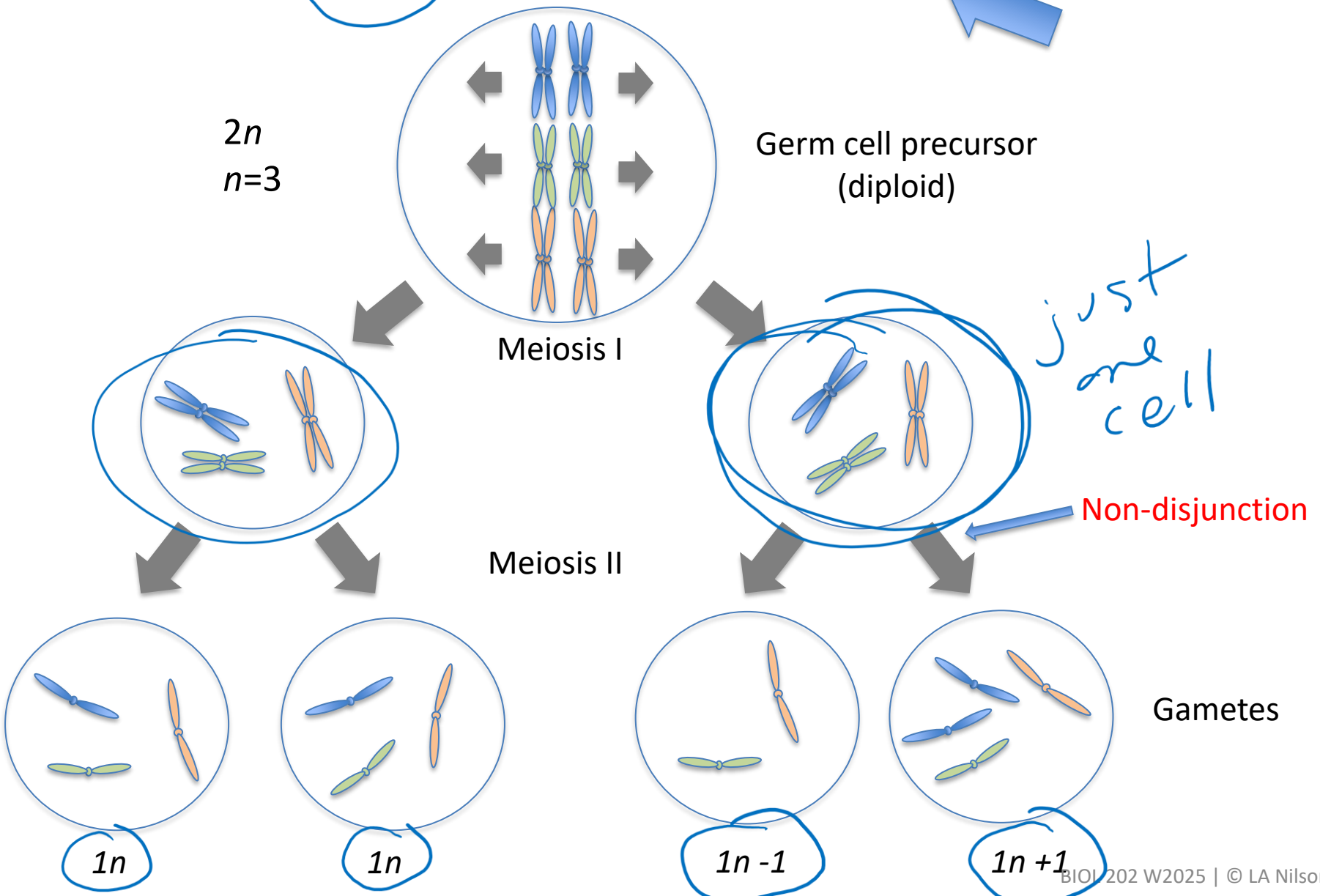
Nondisjunction is usually a rare failure of a basic cellular process.

Remember that crossing over (meiotic recombination) occurs during meiosis I, when homologs are paired.

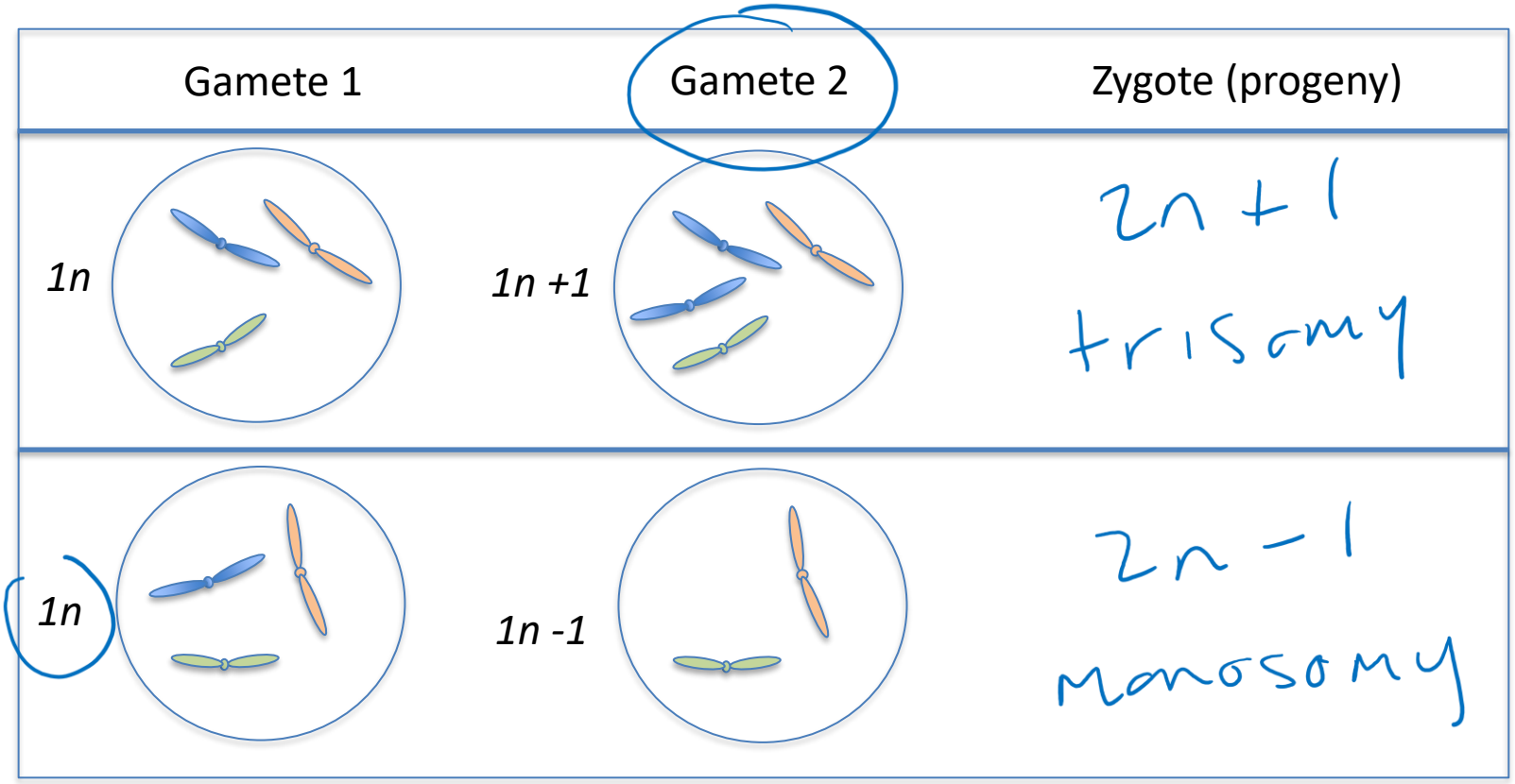
Some evidence that crossing over is required for normal nondisjunction:

1. In Drosophila (and human) trisomies the extra chromosome is non-recombinant (i.e. no crossovers).
2. Mutations that block crossing over also lead to more nondisjunction.

Non-disjunction during meiosis 2: 50% aneuploid gametes



Progeny produced by aneuploid gametes



Where else have we seen the generation of aneuploid gametes?

Example: unpaired chromosomes during meiosis in triploid individuals (frequent)