Extensions to Mendel

Today's question: Mendel was not aware of linkage. What other patterns of inheritance occur that he didn't describe?

I. **Genetic recombination**
II. **Linkage mapping**
III. **Co-dominance**
IV. **Gene x gene and gene x environment interactions**
V. **Pleiotropy, multiple allelism, etc.**

(cell phones off, please)

III. Linkage

A. Morgan's lab found a series of genes on the X chromosome (inheritance patterns like *white*)

B. Notation for linked genes

X-linked linked genes: X^{wY} (*y* = yellow body)

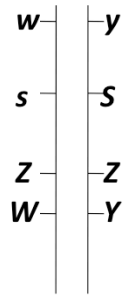
Autosomes: *AC*/*ac* or *AC*//*ac*; gametes as AC

Introduce putting genes on chromosomes when doing crosses … do Xs, pea traits

Draw these chromosomes

Q1. Draw the chromosomes of a female fly, genotype $X^{ws}X^{WS}$ *ZY//Zy*

1.



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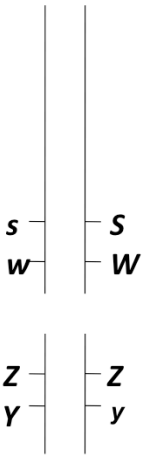

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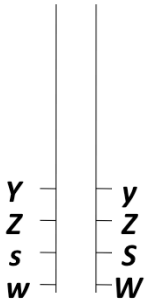

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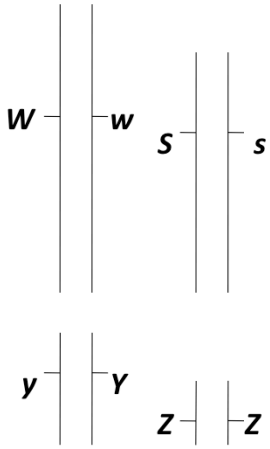

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Q2. The *y* chromosome contains very few genes, none of which are essential for fitness. The *X*, in contrast, contains many essential genes. Why the difference?

1. **Biologically, males are the weaker sex.**
2. **Males are haploid for X-linked traits.**
3. **Females are diploid for X-linked traits.**
4. **Females lack genes that are found on the Y.**

4

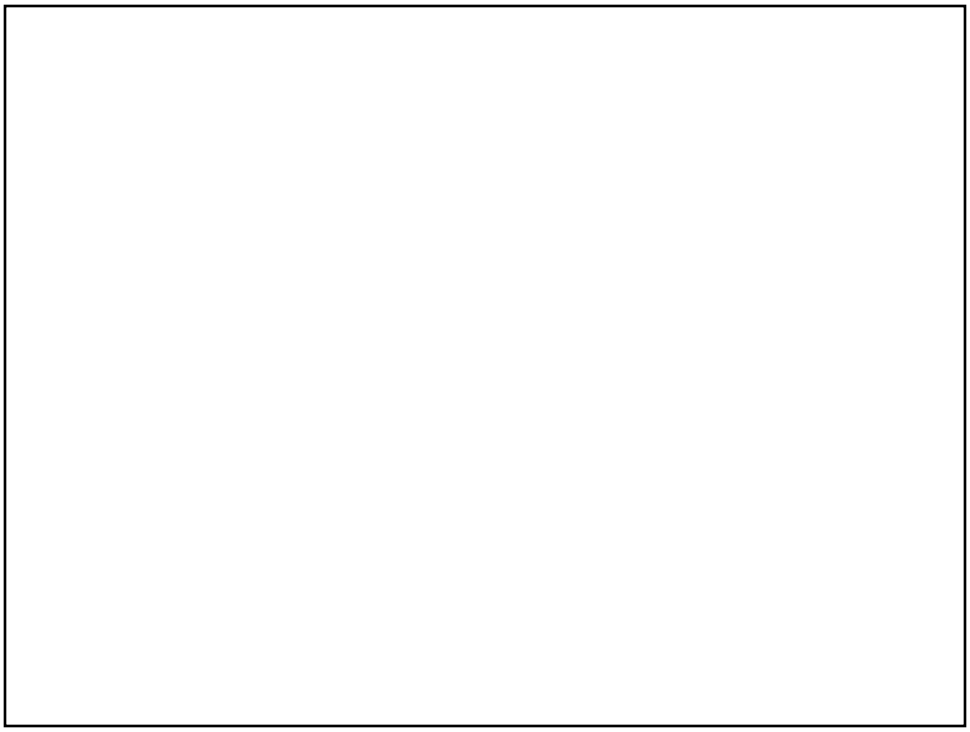
I. The discovery of genetic recombination

Morgan's first cross with linked genes
X^Y = normal body color; X^y = yellow body color

Parental genotypes: $X^{wY}\,X^{wY}$ x $X^{Wy}\,Y$

F_1 females: **F_1 males:**

Let F_1s mate. What are the genotypes and phenotypes of F_2 MALE offspring?



F1s: females X^{wY} X^{Wy} all of the F2 males get a Y chromosome from their dad, and one of these 2 Xs from their mom

Answer:

$X^{wY}Y$ white eyes, normal body 4,292

$X^{Wy}Y$ red eyes, yellow body 4,605

Also: white eyes, yellow body 86

Also: red eyes, normal body 44

What are the genotypes of the weird males?

Crossing over as a physical mechanism for genetic recombination.

White eyes, yellow body X^{wy} Y

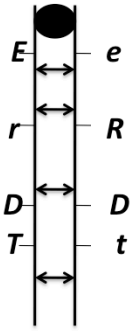
Red eyes, normal body X^{WY} Y

Do DEMO

Students to draw crossing over in F_1 females (X^{wY} X^{Wy})

Ask: what are the products if crossing over happens here … here … here

Q3. Suppose that crossing over occurs as shown below. What are the genotypes of the recombinant chromosomes that result?



1. ***ErDt*** **and** ***eRDT***
2. ***ErDT*** **and** ***eRDt***
3. ***ERDt*** **and** ***erDT***
4. ***ERDT*** **and** ***erDt***

1

Q4. Several of the traits that Mendel worked with are linked. Why did the linked traits appear to assort independently, in dihybrid crosses? (F_2s had 9:3:3:1 ratios)

1. **No recombination occurred.**
2. **The parentals were heterozygous—NOT "pure breeding."**
3. **Sex linkage doesn't occur, as peas don't have sex chromosomes.**
4. **The genes are 50cM apart on the same chromosome.**

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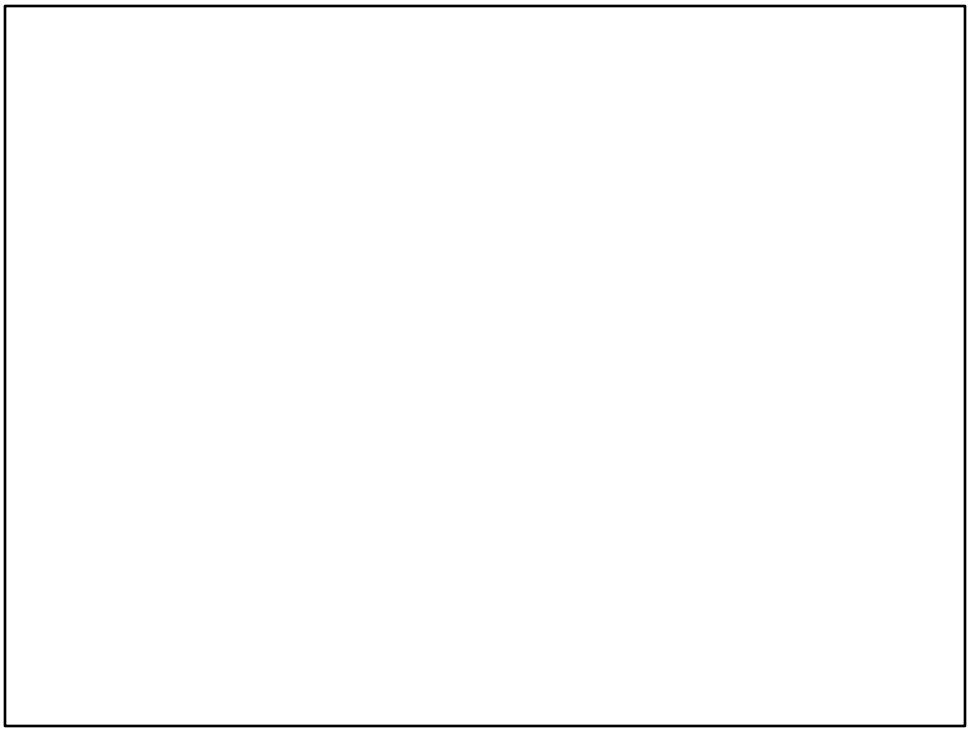


II. Linkage mapping

Sturtevant's insight: The percentage of recombinants is proportional to the physical distance between genes.

Yellow is at 0

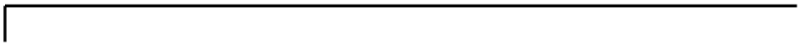
Yellow and white eye: 1.4% recombinants

Yellow and sable body: 43% recombinants

Sable and white eye 41.6%

Crossveinless wings and sable: 29.3% recombinants

Crossveinless wings and white: 12.3% recombinants

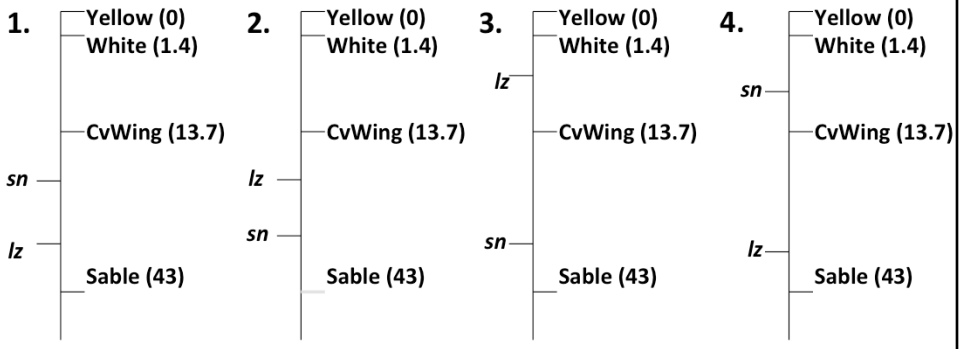


0 1.4 13.7 43

Yellow white cv wings sable

Q5. Place the singed bristles and lozenge eyes genes on the fly X chromosome, based on the recombination frequencies given below.

	White	Cv wings	Sable
Singed bristles (*sn*)	19.6	7.3	22
Lozenge eyes (*lz*)	26.3	14	15.3



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II. Co-dominance
All of the alleles that Mendel analyzed were completely dominant or completely recessive with respect to each other.

ABO blood types in humans
***I^A* allele: Glycoprotein A on red blood cells**
***I^B* allele: Glycoprotein B on red blood cells**
***i* allele: no gene product on red blood cells**

I^AI^A* and *I^Ai	**A blood type**
I^BI^B* and *I^Bi	**B blood type**
I^AI^B	**AB blood type**
ii	**O blood type**

Ask: what are the dominance relationships between I^A, I^B, and i?

NOTE: co-dominance is common at the molecular level

III. Gene x gene and gene x environment interactions

Implications for inheritance: When studying the effects of a gene, you need to control for "genetic background" (other genes present) and the physical environment.

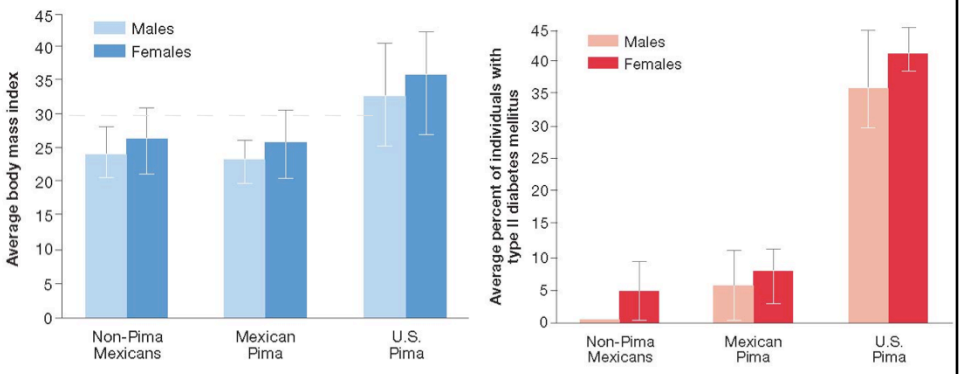
Case 1: Inuit residents of Barrow, Alaska, where people over 35 had not attended American-style schools.

Age	% diagnosed myopic (sample size)
6-35	42 (348)
36-88	5 (160)

State whether these data are evidence of a gene x gene or a gene x environment interaction. Explain your logic.

Answer: gene x environment interaction; genetic background has not changed, but the environment did—reading books in American-styple schools induced myopia in younger people

Case 2: Genetically, Pima people from Mexico and the sw USA are indistinguishable.



Explain BMI and “obesity line”

Assume that if the black lines on different bars do not overlap, it indicates statistically significant differences.

1. Explain what the data in the left graph mean.

2. Explain what the data in the right graph mean.

3. Some researchers suggest that there is a connection between the two graphs. State this as a hypothesis.

4. State whether these data indicate a gene x gene or a gene x environment interaction, or both. Explain.

BMI (obesity) is much higher in U.S.Pima; no difference b/t Mexicans and Mexican Pima

Rates of type II diabetes are much higher in U.S.Pima; no difference b/t Mexicans and Mexican Pima except for males

Increased BMI makes development of type II diabetes more likely

Gene x environment interaction, based on differences in diet and rates of physical activity