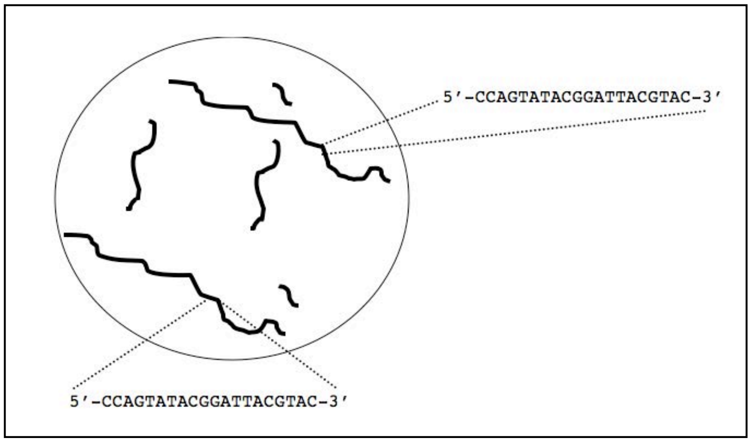
The key: 7.013 Recitation 4 – Spring 2018

1. Below is pictured the nucleus from a skin cell taken from a mouse (named Mouse #1), with the chromosomes shown in bold.



a) Is the cell haploid or diploid? *Diploid*

b) Let's say we blew up a region of the longest chromosome to look at its sequence at one small gene.

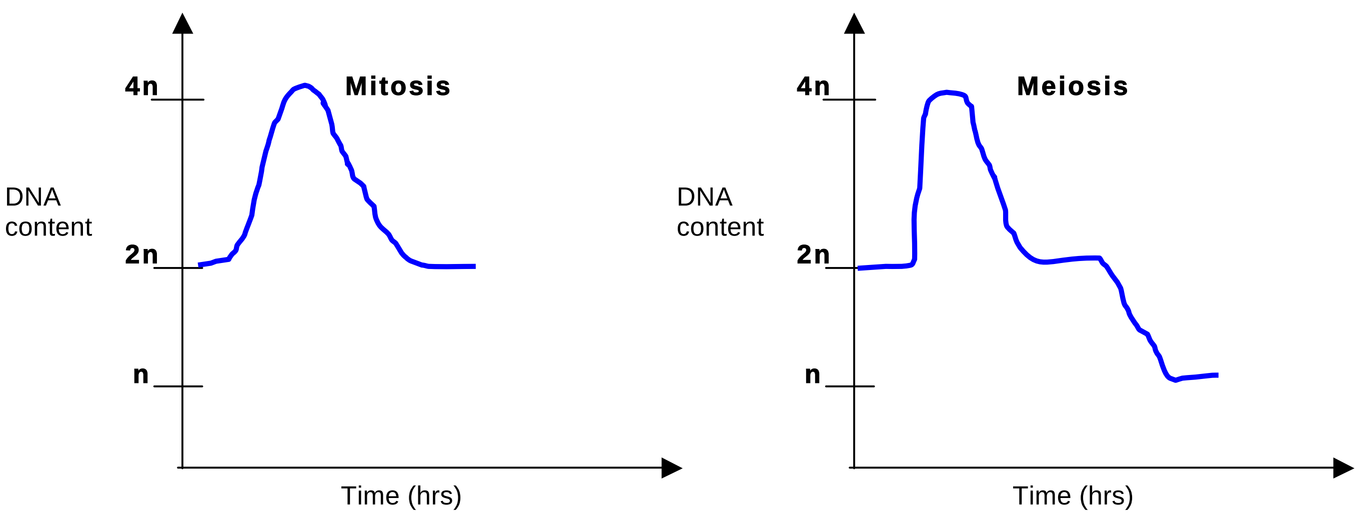
i. Is Mouse #1 homozygous or heterozygous for this gene? *Homozygous since the two sequences are identical*

ii. When you zoom in on the same locus on the long chromosome in a cell from Mouse #2 you find that its two homologous chromosomes have the sequences. How might we write the genotypes of Mouse #1 and Mouse #2 if Sequence #1 encodes a functional protein but Sequence #2 encodes a protein that no longer works? ***(Note:** Use the upper case or lowercase A while writing the genotypes).*

5'-CCAGTATACGGA**G**TACGTAC-3'	5'-CCAGTATACGGATTACGTAC-3'
Sequence 1	**Sequence 2**

It should be Aa

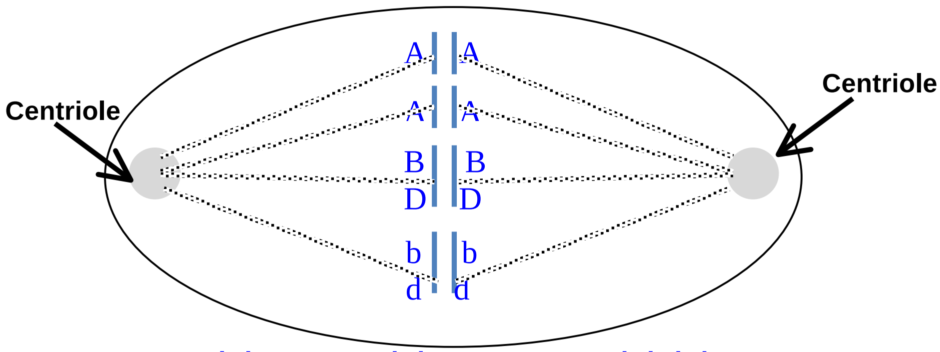
2. In a diploid cell (2n), that is undergoing cell division, draw a graph showing the variation in the DNA content (n = haploid) against time for the mitosis and meiosis.



3. You are following the segregation of three genes; A, B and D in Heidi's cells (**genotype: $AAX^{BD}X^{bd}$**). ***Note:** Gene A is located on the autosome whereas Genes B and D are on the X chromosome.*

a) Give the possible genotype(s) of a cell from **Heidi's dad** for A, B and D genes. ***Note:** Assume that Heidi's dad is homozygous for Gene A.* ***$AAX^{BD}Y$ or $AAX^{bd}Y$***

b) Assume that a **somatic cell** (shown below) from Heidi undergoes cell division. Draw the arrangement of A, B and D genes at the metaphase plate of this dividing cell. ***Note:*** *The centrioles at the two ends are drawn for you.*



$AAX^{BD}X^{BD}X^{bd}$ and AAX^{bd} or $AAX^{bd}X^{bd}X^{BD}$ and AAX^{BD}

c) Assume that the **somatic cell** drawn above undergoes **nondisjunction** of **one** X chromosome carrying B and D genes. All other chromosomes separate normally. Give the genotypes of **all** possible daughter cells in terms of A, B and D genes.

d) Heidi has a daughter whose genotype is **$AAX^{BD}X^{bd}X^{bd}$**. Could the presence of the extra X chromosome be explained by nondisjunction in part (c)? Why or why not?
No, the daughter can have this genotype only if there was nondisjunction event that resulted in Heidi producing a gamete that had an extra X chromosome. Non-disjunctions in somatic cell of an individual are not passed on to the subsequent generations.

You want to study petal color (red or white) in a variety of plants. Gene A that is located on an autosome, regulates this trait.

4. You perform the following **monohybrid cross**.

Red petals (P1) **X** **White petals (P2)**

Genotype of P1: ***AA*** | **Genotype of P2:** ***aa***

↓

F1: 1000 plants all with Red petals

Genotype of F1: ***Aa***

a) In the shaded boxes to the left, give the **genotype(s)** of P1, P2 and F1 plants. ***Note:*** Represent the allele of Gene A associated with the dominant phenotype as ***"A"*** *and recessive phenotype as* ***"a"***

b) You mate two **F1 plants** to obtain 1000 plants in F2 generation.

iv Fill in the Punnett square to the right for this cross.

Gametes-→ ↓	A	a
A	AA	Aa
a	Aa	aa

v List the **phenotypes and corresponding ratio** of the F2 plants for petal color.

Phenotype(s) and corresponding ratio: ***Red (3): White (1)***

vi List the **genotypes and corresponding ratio** of the F2 plants for petal color.

Genotype(s) and corresponding ratio: ***AA (1); Aa(2): aa(1)***

c) Using a Punnett square, design a mating experiment that can help you test whether a plant having red petals is homozygous or heterozygous for the alleles of Gene A.

Gametes-→ ↓	A	A
a	Aa	Aa
a	Aa	Aa

ii. If the test plant was **homozygous** for the alleles of Gene A…

- **Phenotype(s) and ratio** of the resulting plants: ***All red***
- **Genotype(s) and ratio** of resulting plants: ***Aa***

Gametes-→ ↓	A	a
a	Aa	aa
a	Aa	aa

iii. If the test plant was **heterozygous** for the alleles of Gene A…

- **Phenotype(s) ratio** of the resulting plants: ***Red (1): White (1)***
- **Genotype(s) ratio** of resulting plants: ***Aa (1): aa (1)***

d) You also want to study leaf shape (wide or narrow) that is regulated by Gene B in the same variety of plant. **Note:** Genes A and B *are located on two different autosomes. Gene B can exist as* ***"allele B"*** *(associated with the dominant phenotype) or* ***"allele b"*** *(associated with the recessive phenotype).*

You perform a dihybrid cross between P1 and P2 plants both of which are true-breeding for the above traits.

Red petals, narrow leaves (P1) x **White petals, wide leaves (P2)**

Genotype of P1: AAbb

Genotype of P2: *aaBB*

↓

F1: Red flowers, wide leaves

Genotype of F1: *Ab/aB*

In the shaded boxes above, give the **genotype(s)** of P1, P2 and F1 plants by using the specified notation for the alleles of Gene A (petal color) and Gene B (leaf shape)

e) You mate an **F1 plant with another plant that has white petals and narrow leaves.** You obtain 1600 plants in the F2 generation.

iii. Give the likely **genotype** of the plant that has white petals and narrow leaves: ***aabb***

iv. If Gene A and Gene B **assort independently,** how many F2 plants will have white petals and narrow leaves? ***400***

f) If you **mate two F1 plants** to get 1600 plants in the F2 generation, how many of these will have white petals and narrow leaves? ***100***

5. Tomato plants can be **tall** or **short** and have **notched** or **smooth** leaves. You cross a tall, smooth leafed plant with a short, notched leafed plant. All of the progeny are **tall**, and **notched** leafed.

a) Which traits are dominant and which are recessive? *Tall & notched*

b) What are the genotypes of the two **true-breeding** parents? *Use the letters H or h to represent the alleles of the height gene and the letters S or s to represent the alleles of the leaf gene. In each case, use the uppercase letter for the allele associated with the dominant phenotype and the lower case letter for the allele associated with the recessive phenotype.*

Tall & smooth: HHss *Short and notched; hhSS*

c) Two tall, notched F1 plants were crossed (self cross) to get 1600 F2 plants

iii. What ratio of phenotype do you expect in the F2 generation?
Tall and notched: Tall and smooth: short & notched: short & smooth = 9: 3: 3: 1

iv. If you get 400 plants in F2, how many of these will be homozygous recessive for both traits?
25

d) You cross an F1 Plant with a double homozygous recessive plant (genotype: hhbb) and get 1600 plants in F2 generation. Give the four classes of the F2 plants that you will see. Give the genotype, phenotype and the number of each of F2 classes generated.

Tall & smooth (400): Short & notched (400): Tall and notched (400): short and smooth (400)

. In fruit flies, the "B/b" gene and the "G/g" gene are linked. In one specific fly whose genotype is GgBb, "B" is linked to "g" on the maternal chromosome #2, and "b" is linked to "G" on the paternal chromosome #2.

a) List all parental type (non-recombinant) gametes by genotype that could be produced by this GgBb fly. *Non-recombinant gametes are Bg and bG.*

b) List all recombinant gametes by genotype that could be produced by this GgBb fly.
Recombinant gametes are BG and bg.

c) Say that 40% of all gametes produced by the GgBb fly are "Bg." What percentage of all gametes produced by this fly are recombinants? *20% of the gametes are recombinants.*

d) As the recombination frequency between two genes on the same chromosome rises, does the physical distance between those two genes lower **or** rise?
Physical distance is directly proportional to the recombination frequency. So the distance increases with the increase in recombination frequency