Class 15 9/27/17
Chromosome Theory

- **FRIDAY 9/29 is a REQUIRED ATTENDANCE DAY – VGL session**
- Announcements
- Class administration
- Check iLearn for suggested problems
- **Office hours HH668C:**
  - **TODAY 9/25 rescheduled to THU 9/28 3 – 5pm**

Virtual genetics lab "recap"

- **Virtual Genetics Lab Session 1, Friday, 9/8**

  The whole class worked the SAME MONOHYBRID CROSS problem
  - Available on iLearn (Week 3)
    - The original wr2 file for the problem
    - The "worked" wr2 files for each section
    - The PDF summarizing the cages for each section
  - **YOUR TEAM REPORT (one team, one report)**
    - **Due on FRIDAY 9/29, 11:59pm on iLearn**
- **Virtual Genetics Lab Session 2, Friday 9/15**

  Each team worked on a DIHYBRID CROSS problem (each team worked a different problem)
  - **YOUR TEAM "REPORT" due at end of class that day by e-mail**
  - **Your team also e-mailed your wr2 file**
- **Virtual Genetics Lab Session 3, Friday 9/29**

Romberg Tiburon Center Seminar Series

http://rtc.sfsu.edu/seminar/index.htm

Wednesday, 9/27/17
Bay Conference Center, 3:30PM

Christopher Edwards
U.C. Santa Cruz
Coupled Biophysical Data Assimilation and its Application to the Recent Warm Blob and El Nino

http://oceanmodeling.ucsc.edu/

Biol 871 Colloquium in Microbiology, Cell & Molecular Biology

seminar

Thursday, 9/28/17
SCI 210, 2:10 pm

http://biology.sfsu.edu/content/MCMB

Hunter Fraser
Stanford University
Mapping human regulatory variation

https://web.stanford.edu/~hbfraser/

Biol 572/872 Ecology, Evolution, & Conservation Biology Colloquium

seminar

Tuesday, 10/3/17
HH 543, 2:10pm

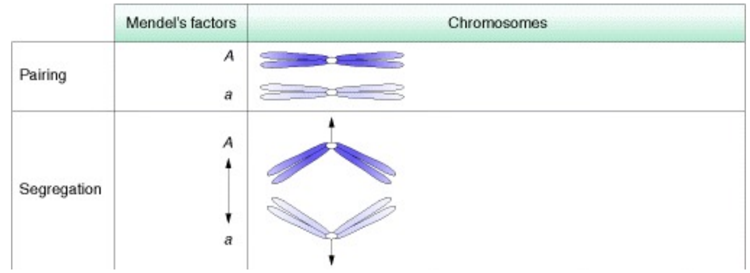
http://biology.sfsu.edu/content/EEC

Sara Baguskas
SF State
Department of Geography & Environment

Coastal fog and its impact on the energy, water, and carbon fluxes in a California agricultural system

http://www.sarabaguskas.com/

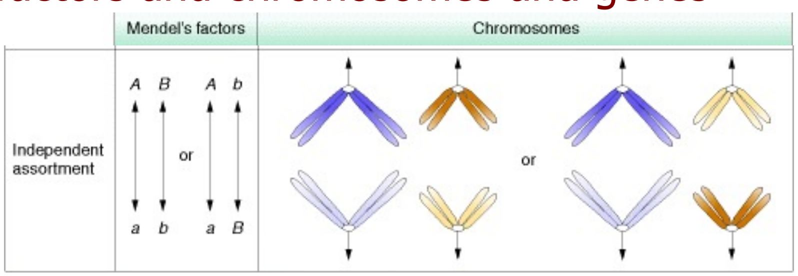
Correlation between behavior of unit factors and chromosomes and genes



- Postulate: **Segregation of unit factors during gamete formation**
- The pair of unit factors segregate during gamete formation
  - Maternal and paternal factors separate

Figure 3.5

Correlation between behavior of unit factors and chromosomes and genes



- Postulate: **Principle of Independent Assortment**
- Distinguish between the two members of a pair of homologous chromosomes: Maternal or paternal
- Following independent segregation of each pair of homologs (meiotic anaphase I), each gamete receives one member of each nonhomologous chromosome independently

Figure 3.5

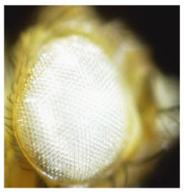
X-linkage

- Genes present on the X chromosome exhibit unique patterns of inheritance due to the presence of only one X chromosome in males.
- X,Y system used for sex determination by many animal (such as humans) and plant species
  - X is a large chromosome and encodes many genes
  - Y is a small chromosome with few genes (has pairing region for synapsis with X chromosome)
- Males therefore have a single copy of most genes encoded by the X chromosome, hemizygous
  - Each gamete inherits a different sex chromosome = heterogametic
  - Females are homogametic homogametic (each gamete inherits the same sex chromosome)
- These genes have unique inheritance/expression properties resulting from their "X-linkage"

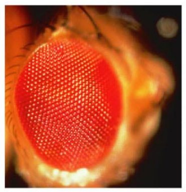
X-linkage in *Drosophila*

- *Drosophila* eye color was one of the first examples of **X-linkage** described
- First documented by Thomas Morgan, 1910
  - White-eyed mutant
  - Inheritance pattern clearly related to sex of parent carrying allele and offspring

Morgan



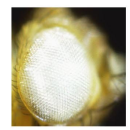
white

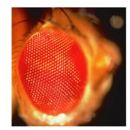


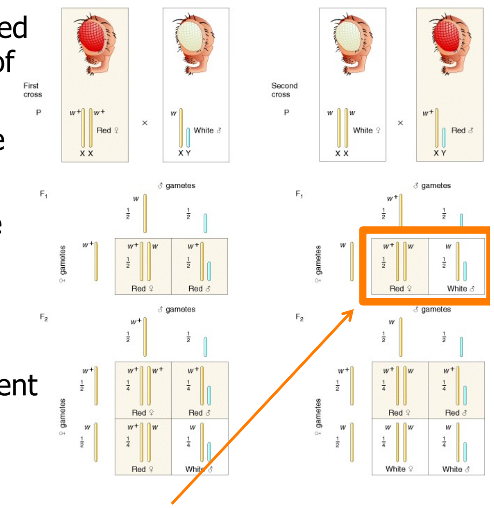
Wild type

Inheritance of White-eyed Trait

- Results depend on sex of red and white-eyed members of P generation
- Red female and white male
  - F1 all red
- White female and red male
  - F1 ½ red and ½ white
  - but **all red are female** and all white are male
- F2 results also sex-dependent

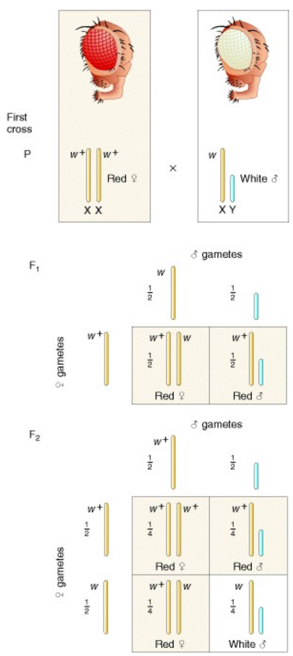






crisscross pattern

Figure 2-15



When the P1 male is white-eyed

- Morgan hypothesized that the recessive *white* allele is on the X chromosome
- In the F1, all female progeny inherit the *white* X chromosome, but all males inherit the wt w^+ from mom
- In the F2, all female progeny are either w^+/w^+ or w^+/w, but 1/2 of male are w^+/Y and 1/2 are w/Y.
- REVIEW THE INHERITANCE PATTERN IN THE RECIPROCAL CROSS

Figure 2-15

The Binomial Theorem

- The binomial theorem can be used to calculate the probability of any specific set of outcomes among a large number of potential events.
- Used to determine the probability of a particular combination, rather than going through all possibilities.

- Example 1: What is the probability that in a family of 4 children, 2 will be male and 2 female?

There are 3 distinct methods to answer this question

Brute Force Method: Going through all the possibilities - Method 1

- Ex. 1: What is the probability that in a family of 4 children, 2 will be male and 2 will be female?

p (MMFF) = (1/2)(1/2)(1/2)(1/2) = 1/16 or
p (MFMF) = 1/16 or
p (MFFM) = 1/16 or
p (FMMF) = 1/16 or
p (FMFM) = 1/16 or
p (FFMM) = 1/16 or
Using the **Sum Law**: p = 6 x (1/16) = 6/16 = 3/8

Use of Binomial Theorem - Method 2

- When one of two outcomes is possible during each of a succession of trials, $(a + b)^n = 1$
  - where a and b are probabilities of two possible outcomes and n = # of trials.

Ex. 1: What is the probability that in a family of 4 children, 2 will be male and 2 female?

Let $a = P_{male} = 1/2$
Let $b = P_{female} = 1/2$
n = 4

- Expand the binomial:

$(a + b)^4 =$

Binomial expansion

N	Binomial	Expanded binomial
1	$(x + y)^1$	$= 1x + 1y$
2	$(x + y)^2$	$= 1x^2 + 2xy + 1y^2$
3	$(x + y)^3$	$= 1x^3 + 3x^2y + 3xy^2 + 1y^3$
4	$(x + y)^4$	$= 1x^4 + 4x^3y + 6x^2y^2 + 4xy^3 + 1y^4$
5	$(x + y)^5$	$= 1x^5y^0 + 5x^4y^1 + 10x^3y^2 + 10x^2y^3 + 5x^1y^4 + 1x^0y^5$

$$(a+b)^0 = 1$$
$$(a+b)^1 = a + b$$
$$(a+b)^2 = a^2 + 2ab + b^2$$
$$(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$
$$(a+b)^4 = a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$$
$$(a+b)^5 = a^5 + 5a^4b + 10a^3b^2 + 10a^2b^3 + 5ab^4 + b^5$$

http://www.math10.com/en/algebra/probabilities/binomial-theorem/binomial-theorem.html

Pascal's Triangle: Coefficients for the binomial expansion

1
1 1
1 2 1
1 3 3 1
$\boxed{\mathbf{1 \quad 4 \quad 6 \quad 4 \quad 1}}$
1 5 10 10 5 1

$$(x+y)^5 = 1x^5y^0 + 5x^4y^1 + 10x^3y^2 + 10x^2y^3 + 5x^1y^4 + 1x^0y^5$$

http://www.statisticslectures.com/topics/pascalstriangle/

Use of Binomial Theorem - Method 2

- When one of two outcomes is possible during each of a succession of trials, $(a + b)^n = 1$
  – where a and b are probabilities of two possible outcomes and n = # of trials.

Ex. 1: What is the probability that in a family of 4 children, 2 will be male and 2 female?

Let $a = P_{male} = 1/2$
Let $b = P_{female} = 1/2$
$n = 4$

- Expand the binomial:

$(a + b)^4 = a^4 + 4a^3b +$ **$6a^2b^2$** $+ 4ab^3 + b^4$ (the numerical coefficients are determined using Pascal's triangle - see text)

a and b each occur twice, so use: $p =$ **$6a^2b^2$** $=$
$6(1/2)^2(1/2)^2 = 6(1/2)^4 = 6(1/16) = 6/16 = 3/8$

General Formula - Method 3

- The generalized formula is: $$p = \frac{n!}{s!t!}a^s b^t$$

Where n = total number of events
s = number of times outcome a, with probability a occurs
t = number of times outcome b, with probability b occurs

- "!" means factorial, so 4! = 4 X 3 X 2 X 1 *Note 0! = 1*

- For our Example 1: What is the probability that in a family of 4 children, 2 will be male and 2 female?
  n= 4, s= 2, t=2, a= 1/2, b= 1/2

- $p = (4!/2!2!)(1/2)^2(1/2)^2 = [(4x3x2x1)/(2)(2)](1/2)^4 = (24/4)(1/16) = 6/16 = 3/8$

Clicker Question

- The generalized formula is: $$p = \frac{n!}{s!t!}a^s b^t$$

Where n = total number of events
s = number of times outcome a, with probability a occurs
t = number of times outcome b, with probability b occurs

- What is the probability that in a family of 4 children, 3 are male and 1 is female?

A. 1/8
B. 1/4
C. 3/8
D. 1/2