Intro to Genetics

gene - DNA segment located on chromosomes that is passed on from generation to generation

- chromosomes may have 100's of genes on them

homologous chromosomes - chromosomes that make up a pair. They tend to be the same length and have the same centromere position

ex. one chromosome from each parent

gamete - sex cells (sperm and egg), that have 1/2 the number of chromosomes

- human gametes have 23 chromosomes

** the symbol *n* is used to represent the number of chromosomes in a gamete**

- A cell with n number of chromosomes is called **haploid**

fertilization - when one haploid gamete combines with another haploid gamete

n + n

- A cell with 2n number of chromosomes is called **diploid**

Human haploid gamete = 23 chromosomes

Human diploid cell = 46 chromosomes (23 from male and 23 from female

Meiosis

- the process where gametes are formed

- type of division that reduces the number of chromosomes

- a cell that has 2n number of chromosomes will have n number of chromosomes after meiosis

ex. human 46 before meiosis ⟶ 23 after meiosis

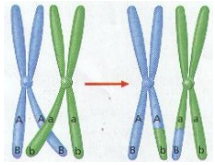
- Involves 2 consecutive cell divisions called Meiosis I and Meiosis II

Mitosis →
1) Prophase
2) Metaphase
3) Anaphase
4) Telophase

Meiosis I

Interphase - carry out cell processes, replicate DNA

Prophase I
- chromosomes become visible
- 2 sister chromatids
- chromosomes begin to form pairs in a process called synapsis
- centrioles begin to migrate, spindle fibers form
- crossing over occurs



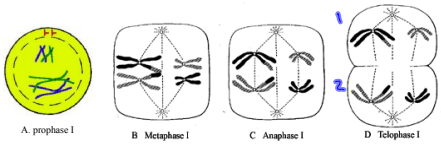
Metaphase I
- pairs of homologous chromosomes line up at the equator of the cell
- spindle fibers attach to centromere of each chromosome

*** During mitosis individual chromosomes (2 sister chromatids) line up in the center, during meiosis 2 chromosomes line up in center***

Anaphase I
- homologous chromosomes are pulled to opposite poles of cell
- chromosome number is reduced from 2n to n

*** During mitosis sister chromatids split, during meiosis each homologous chromosome still has 2 sister chromatids

Telophase I
- the cells divide and go through cytokinesis and begin interphase again, but they do not replicate their DNA again
- results in 2 daughter cells



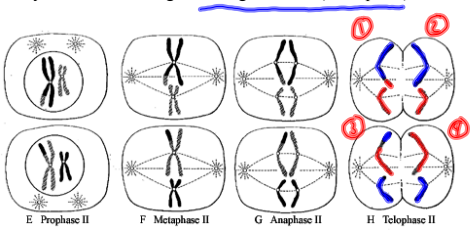
Meiosis II

Prophase II
- spindle apparatus forms again
- chromosomes condense

Metaphase II
- chromosomes positioned at equator by spindle apparatus
- haploid # of chromosomes line up at equator
  - mitosis = diploid at this step

Anaphase II
- sister chromatids are pulled to opposite ends of cell

Telophase II
- nuclear membrane and nuclei form again
- cytokinesis resulting in 4 daughter cells (all haploid)



Mitosis vs Meiosis

Mitosis	Meiosis
- one division	- 2 divisions
- DNA replication during interphase	- DNA replicate before meiosis I
- no synapsis occurs	- synapsis occurs (crossing over)
- 2 identical cells formed each cycle diploid	- 4 haploid cells per cycle
- daughter cells genetically identical	- not identical because of crossing over
- occurs in body cells	- occurs in reproductive cells
- growth and repair	- forms gametes
	4 sex cells

Meiosis provides variation

- depending on how chromosomes line up and cross over determine genetic variation

Mendelian Genetics

Gregor Mendel

- Austrian monk and plant breeder
- studied mathematics of inheritance in garden pea plants
- followed various traits of plants he bred
  - color, flowers, height, etc...

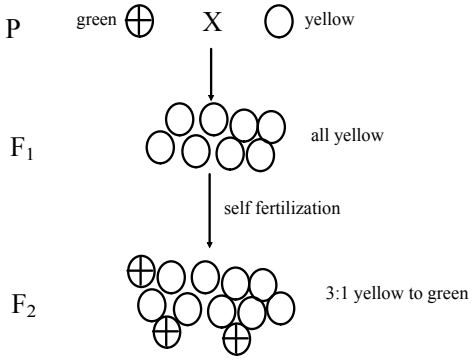
genetics - the science of heredity

- Mendel is regarded as the father of genetics

Mendel's Peas

- noticed some plants always produced green seeds and some always produced yellow seeds (always produce green, always produce yellow)
- He cross pollinated a true green and true yellow plant and he called this the P generation (parent)
- all of the resulting offspring from the green/yellow cross were yellow
  - this was called the F_1 generation
- He then crossed two of the F_1 yellow seeds and created the F_2 generation
  - he noticed that in this generation there was exactly a 3:1 ratio of yellow to green peas
- Mendel studied 7 different traits: color, flower color, pod color, seed shape, seed pod shape, stem length, and flower position

ALL OF THE TRAITS HAD A 3:1 RATIO



alleles - an alternative form of a single gene passed from generation to generation

ex. green seeds and yellow seeds

Dominant - a trait that appears in the F_1 generation (stronger trait)

- shown by a capital letter Y

Recessive - a trait that was masked in the F_1 generation (less common)

- shown by a lower case letter y

- in the case of seed color yellow was dominant and green was recesive

Homozygous - an organism with two of the same alleles for a particular trait

YY = yellow seed yy = green seed

Heterozygous - an organism with two different alleles for a particular trait

Yy = yellow seed (dominant is shown)

Homozygous dominant YY → allele

Homozygous recessive yy

Heterozygous Yy → allele

Genotype vs. Phenotype

genotype - the organisms allele pairs Letters DD Cc bb Qq

YY = yellow Yy = yellow

- both are yellow but they have different genotypes

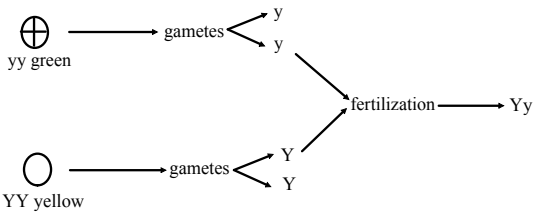
phenotype - the observable outward expression of an allele pair

YY = yellow Yy = yellow yy = green

- the color of the seed is the phenotype

- what we see

Law of segregation - two alleles for each trait separate during meiosis and two alleles unite during fertilization



Y = yellow determining allele
y = green determining allele

Yy Yy YY Yy yy

Yy

Monohybrid Cross and Punnett Squares

- a monohybrid cross is one that involves hybrids for a single trait

Dad yellow

	Y	y
Y	YY yellow	Yy yellow
y	Yy yellow	yy green

mom yellow

Y = yellow
y = green

genotype ratio : 1:2:1 1YY : 2Yy : 1yy

phenotype ratio : yellow: green 3:1

Tall = T
short = t

	t	t
T	Tt	Tt
t	tt	tt

50%

	t	t
T	Tt	Tt
T	Tt	Tt

100%

Dihybrid Cross and Punnett Squares

- a dihybrid cross is one that involves hybrids for a 2 traits

- cross homozygous dominant yellow round with homozygous recessive green wrinkled

Y = yellow y = green
R = round r = wrinkled

YYRR x yyrr

F_1 YyRr x YyRr

	YR	Yr	yR	yr
YR	YYRR	YYRr	YyRR	YyRr
Yr	YYRr	YYrr	YyRr	Yyrr
yR	YyRR	YyRr	yyRR	yyRr
yr	YyRr	Yyrr	yyRr	yyrr

Y = yellow
y = green

R = round seed
r = wrinkled seed

genotype ratio : yellow/round 9 yellow/wrink. 3 green/round 3 green/wrinkled 1

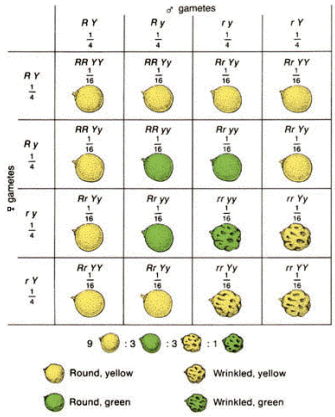
phenotype ratio : 9:3:3:1

Law of Independent Assortment

- random distribution of alleles occur during gamete formation
- genes on separate chromosomes sort independently during meiosis

YYRr

YR Yr YR Yr



Chromosome maps

- crossing over occurs between genes that are farther apart on chromosomes

genetic recombination - new combination of genes produced by crossing over and independent assortment

polyploidy - occurence of one or more extra sets of chromosomes

ex. triploid = 3n

bread wheat = 6n
oats = 6n
sugar cane = 6n