Chapter 10

10.2 Mendelian Genetics

1. Explain the significance of Mendel's experiments to the study of genetics.
2. Summarize the law of segregation and law of independent assortment.
3. Predict the possible offspring from a cross using a Punnett square/genetic diagrams.

Answers:

- Gregor Mendel found a few interesting things while he was breeding his pea plants as a hobby

- He found that specific combinations of pea parents had non-random children (predictable color)

- He conducted an experiment by crossing Homozygous green peas (CC) with homozygous yellow peas (cc)
    - Found that the first generation were all green, he did not know yet but these were all heterozygous green peas
    - The second generation had 75% green and 25% yellow
        - This is because the yellow peas were masked in the first generation, being recessive
        - Later in the second generation there was a 25% chance of getting a homozgous yellow pea again

- The two most notable conclusions are his two Laws of inheritance

    1. **Law of Segregation**

        - Each offspring will **only recieve one** of each gene from each parent
        - This leads to a "blend" of the parents in the child, this leads to genetic variation in the offspring due to recieveing different genes from each parent

    2. **Law of Independent Assortment**

        - All genes are inherited independently of each other

- Means that eye color does **not** effect your skin color for example
    - Ex:
        - Q: If your parents both have heterozygous alleles for cleft chin (Pp) and heterozygous for hair texture (curly dominant) (Cc) and you know the child has a cleft chin, what is the probablility of having straight hair?
        - A: Because of Mendel's Law of Independent Assortment, knowing anything about his cleft chin does not tell us anything about his hair texture, so this information can be ignored.

hair texture	C	c
C	CC	Cc
c	Cc	cc

        - The probability of having curly hair is **25%**
        - EXTRA: To verify the law of Independent Assortment, we can conduct a dihybrid cross

hair texture and cleft chin	PC	Pc	pC	pc
PC	PPCC	PPCc	PpCC	PpCc
Pc	PPCc	PPcc	PpCc	Ppcc
pC	PpCC	PpCc	ppCC	ppCc
pc	PpCc	Ppcc	ppCc	ppcc

Phenotypes:

hair texture and cleft chin	PC	Pc	pC	pc
PC	PC	PC	PC	PC
Pc	PC	Pc	PC	Pc
pC	PC	PC	pC	pC
pc	PC	Pc	pC	pc

        - Restating: given cleft chin (phenotype **p**)
        - There are 4 possibilities with cleft chin
            - **pC**, **pC**, **pC**, **pc**
        - Out of these four possibilities, only one has straight hair (**pc**)
        - We get a result of **25%**, the same as when we use the Law of Independent Assortment
    - If this law is not true, it means if you had black hair for example, you would know that you would more about which eye color you would have

Chapter 10.3 Gene Linkage and Polyploidy

1. Summarize how the process of meiosis produces genetic recombination.
2. Explain how gene linkage can be used to create chromosome maps.
3. Analyze why polyploidy is important to the field of agriculture.

Answers:

1. **Recombination**
    - In Prophase 1 in Meiosis, Synapsis (crossing over) occurs, where the chromosomes which are close to each other swap some DNA
      - Term comes from the chromosomes crossing and switching the ends of the chromatids
    - In Metaphase 1 in Meiosis the arrangement of which chromosome goes to each daughter cell is random
    - In Metaphase 2 in Meiosis, the rotation of the chromosome is random, so which chromatid goes to which cell is also random
2. **Linkage and maps**
    - Gene linkage is when genes that are close to each other physically on the chromosome are less likely to be separated due to their physical proximity

- The probability of closer genes being separated is lower

- Ex:

Gene pair	Probability of being recombined
AB	3%
AC	5%
BC	8%

- Since AB have the lowest probability, we will start with that
    - Since it is the smallest, they are the closest on the chromosome
    - A---B
- The next smallest is AC, but now we do not know if C is on the same side as B or not
    - There are two possibilities:
        - (1) C-----A---B
        - (2) A---B--C
- Lastly there is BC, this has to be the largest distance since it has the highest chance
    - In the first (2) possibility, B and C are close together, so this cannot be our answer
    - We conclude that the gene map is
        - **C-----A---B**

3. **Polyploidy and Agriculture**

- Polyploidy is when a cell has more than two of each chromosome
- Haploids have one of each, diploids have two, and polyploids have more
- Since polyploids have more than two of each chromosome, the cell needs to be bigger to have more space for the increased genetic material
    - This leads to larger fruits (farmers love it)

Chapter 11

Chapter 11.2 Complex Inheritance

1. Distinguish between codominance and incomplete dominance.

2. Predict and analyze the patterns and outcomes (genotype/phenotype) for crosses involving:
    1. Codominance
    2. Incomplete dominance
    3. Multiple alleles
    4. Polygenetic traits
    5. Sex-linked traits
3. Summarize the effect of environment on phenotypic changes.

Answers:

1. **Codominance and Incomplete dominance**
    - Ex: red + white flower
    - In Codominance both alleles are shown, like a red and white flower
    - In Incomplete Dominance, a mixture or something different will show, like a pink flower
2. **Patterns and outcomes (Punnett Squares)**
    1. **Codominance**
        - Alleles R (red) and W (white) are codominant, where RW is pink
        - Cross RW and RW

Color	R	W
R	RR	RW
W	RW	WW

Phenotype

Color	R	W
R	Red	Pink
W	Pink	White

        - 25% chance of Red, 50% of Pink, 25% of White
    2. **Incomplete dominance**

- Alleles R (red) and W (white) are Incompletely dominant

- Cross RW and RW

Color	R	W
R	RR	RW
W	RW	WW

Phenotype

Color	R	W
R	Red	Red and white
W	Red and white	White

- 25% chance of Red, 50% of red and white, 25% of White

3. **Multiple alleles**

- Bunnies have four possible alleles for fur color, listed in most dominant to least dominant:
  - C - Brown
  - c^{ch} - Chinchilla
  - c^{h} - Himalayan
  - c - Albino
- Cross Cc^{h} and $c^{ch}c$

Color	C	c^{h}
c^{ch}	Cc^{ch}	$c^{ch}c^{h}$
c	Cc	$c^{h}c$

Phenotype

Color	R	W
R	Brown	Chinchilla
W	Brown	Himalayan

- 50% chance of Brown, 25% of Chinchilla, 25% of Himalayan

4. **Polygenetic traits**

- There are 5 eye colors:

Eye color	Genotype
Black eyes	BBGG
Dark Brown eyes	BBGg, BbGG
Light Brown eyes	BbGg, BBgg, bbGG
Green eyes	Bbgg, bbGg
Blue eyes	bbgg

- If one parent has Light brown eyes of genotype **BbGg** and the other has Blue eyes, what is the probability that the child will have green eyes

Two eye color genes	BG	Bg	bG	bg
bg	BbGg	Bbgg	bbGg	bbgg
bg	BbGg	Bbgg	bbGg	bbgg
bg	BbGg	Bbgg	bbGg	bbgg
bg	BbGg	Bbgg	bbGg	bbgg

Phenotypes:

Two eye color genes	BG	Bg	bG	bg
bg	Light Brown	Green	Green	Blue
bg	Light Brown	Green	Green	Blue
bg	Light Brown	Green	Green	Blue
bg	Light Brown	Green	Green	Blue

- 50% change of getting green eyes

5. **Sex-linked traits**

- X_g and X_G are the alleles of a sex-linked gene on the X-chromosome

- X_G is dominant, and X_g (baldness) is recessive

- Cross X_GX_g with X_GY

Baldness	X_G	X_g
X_G	X_GX_G	X_GX_g
Y	X_GY	X_gY

Phenotype

Baldness	X_G	X_g
X_G	Hairy Female	Hairy Female
Y	Hairy Male	Bald Male

- 50% chance of Hairy Female, 25% of Hairy Male, 25% of Bald Male

3. Environment and phenotypic changes

- Your phenotype can be effected by the enironment
  - Temperature and sunlight effects skin color
  - Sunlight and water effect the color plants

Definitions

Word	Meaning
Genes	A part of your DNA
Traits	Something that physically shows from your DNA
Gamete	A sex cell that does not one set of chromosomes, they are haploids
Diploid	Contains a pair of all chromosomes
Haploid	Contains one of all chromosomes (half of a diploid)
Polyploid	Contains more than two of each chromosome
Meiosis	The process of getting from a precursor cell to gametes
Precursor Cells	Cells that are capable of making sex cells through meiosis
Homologous	Matching chromosomes

Word	Meaning
Recombination	When the DNA get randomly mixed when producing sex cells in meiosis
Dominant gene	A gene that will show if it is present
Recessive gene	A gene that will only show if it is the only one present
Allele	"Versions" or "types" of a gene
Phenotype	The observed characteristics and traits of a gene
Genotype	The combinations of alleles that make up the gene
Homozygous	Having identical alleles make up the genotype
Heterozygous	Having different alleles make up the genotype
Linked genes	genes that are physically close and tend to not get recombined
Pedigree	A family tree with a traced trait along generations
Incomplete Dominance	When two dominant alleles are equal in power and a trait that is neither of the dominant traits show (ie: red + white ⇒ pink)
Codominance	Similar to Incomplete dominance, but both dominant alleles show instead of mixing (ie: red + white ⇒ red and white)
Multiple Alleles	Instead of having two choices for allele type (dominant and recessive) there can be extra alleles (like blood type)
Sex linked traits	Genes that are on the X chromosome
Polygenic trait	A trait that relies on more than one gene (ie: height, skin color, eye color, fingerprint)