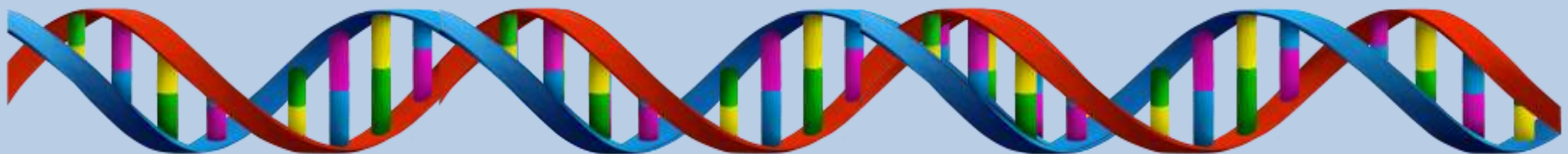
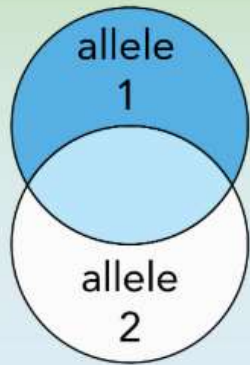


- 1. Which beaker represents CODOMINANCE?**
- 2. Which beaker represents INCOMPLETE DOMINANCE?**
(The beakers are labeled, GET UP AND LOOK)
- 3. What is the real reason that brown eyes are dominant to blue?**



Complex Inheritance

INCOMPLETE DOMINANCE



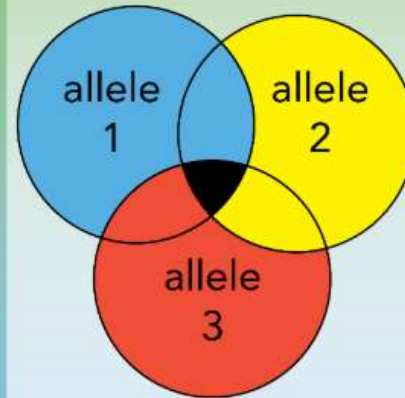
Neither allele is dominant or recessive

CODOMINANCE



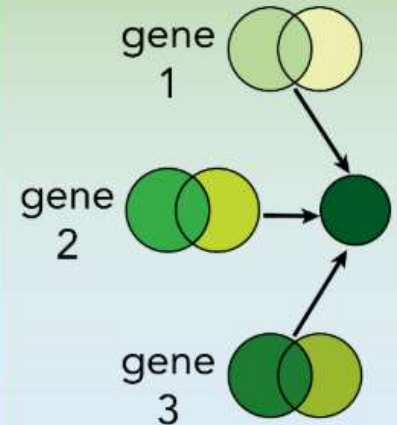
Both alleles are clearly expressed

MULTIPLE ALLELES



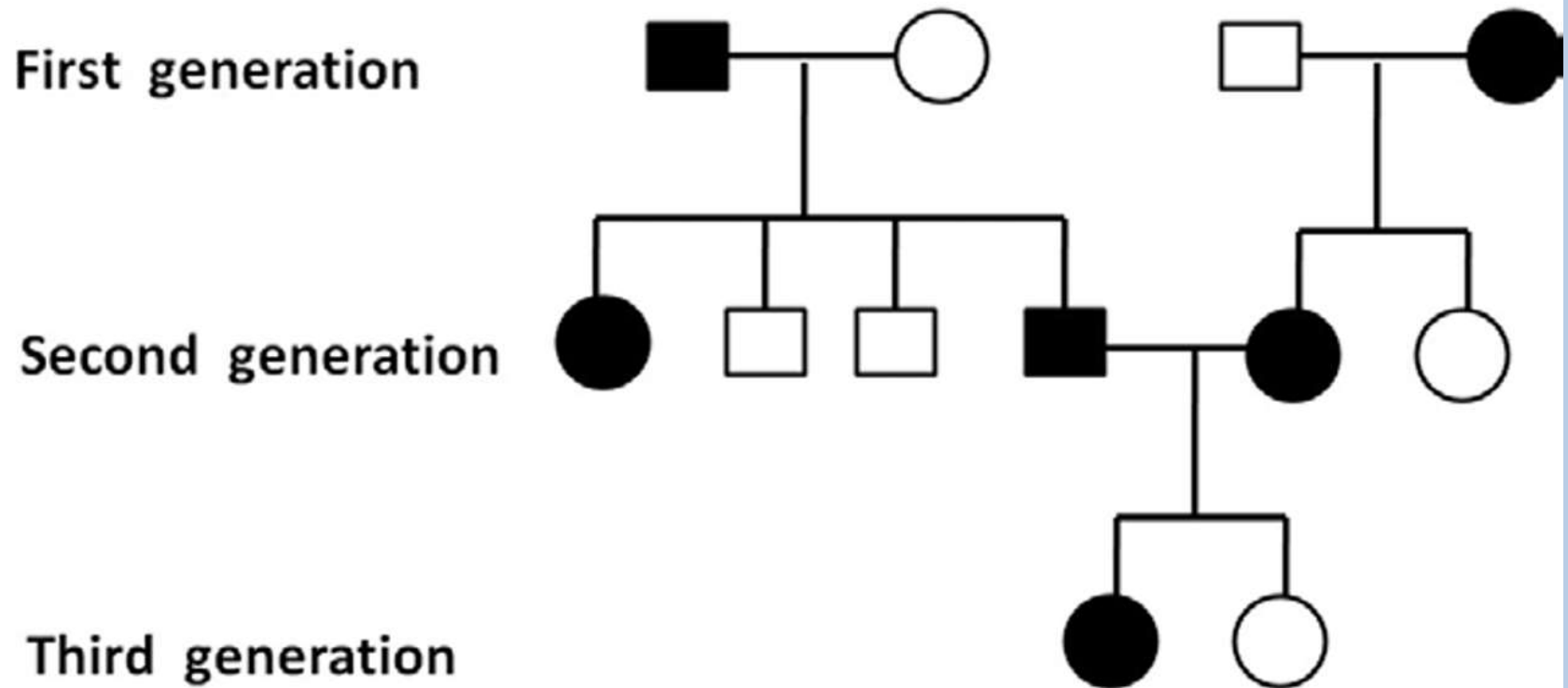
One gene has more than two alleles

POLYGENIC TRAITS

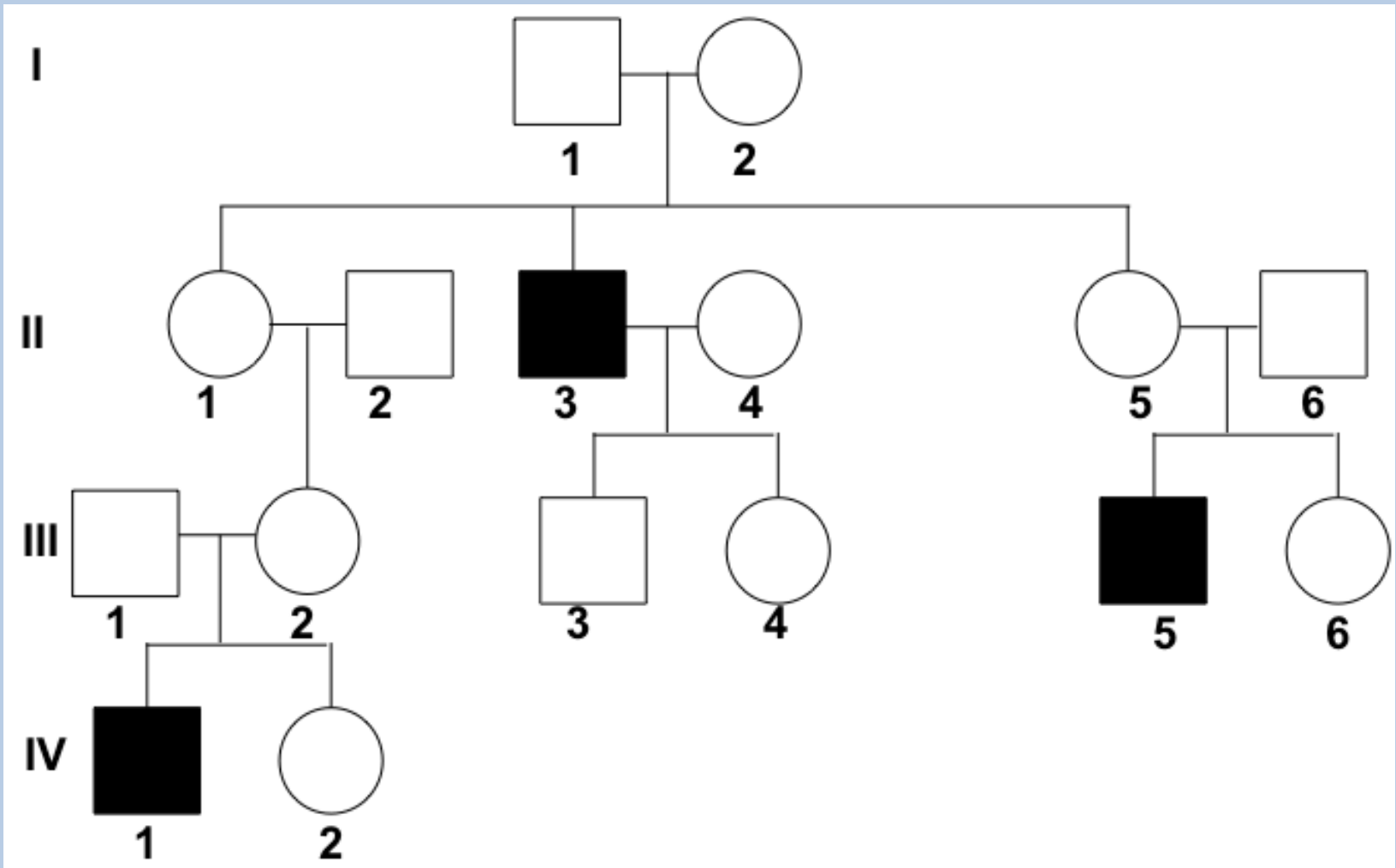


More than one gene controls a trait

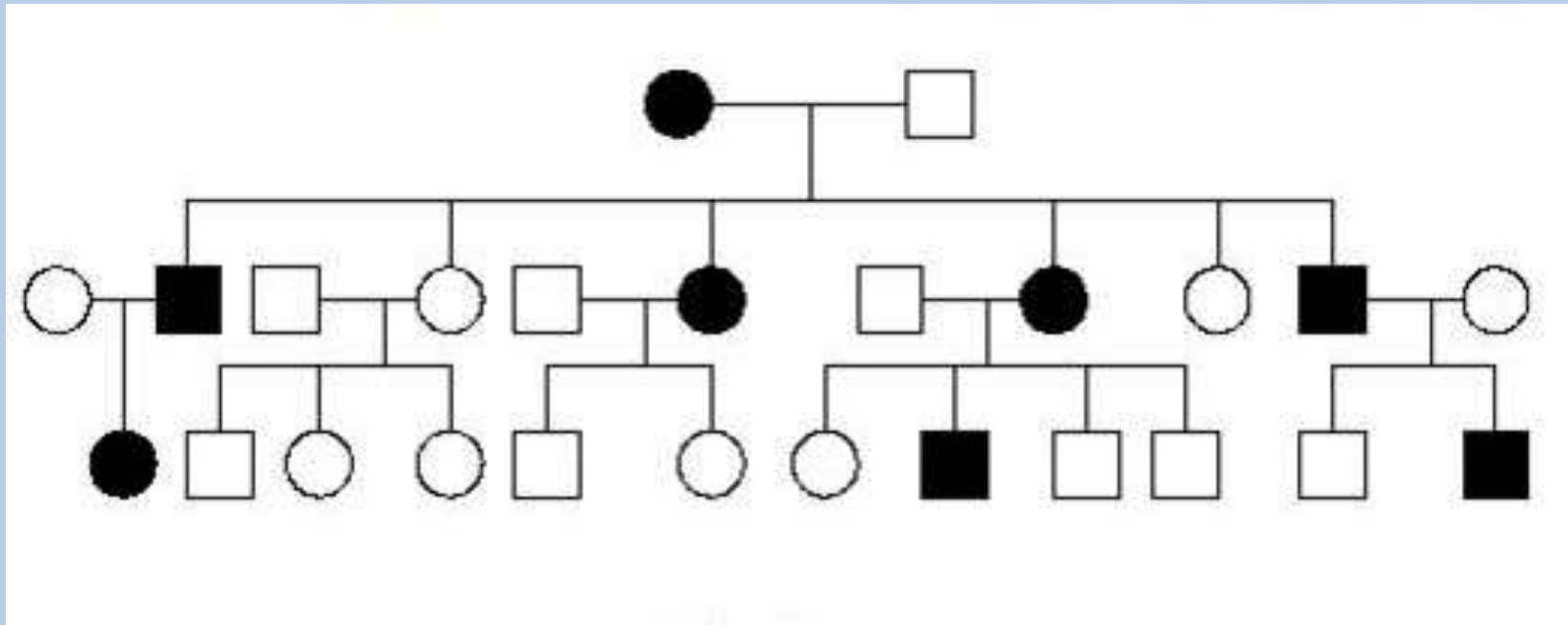
Deciphering Pedigrees



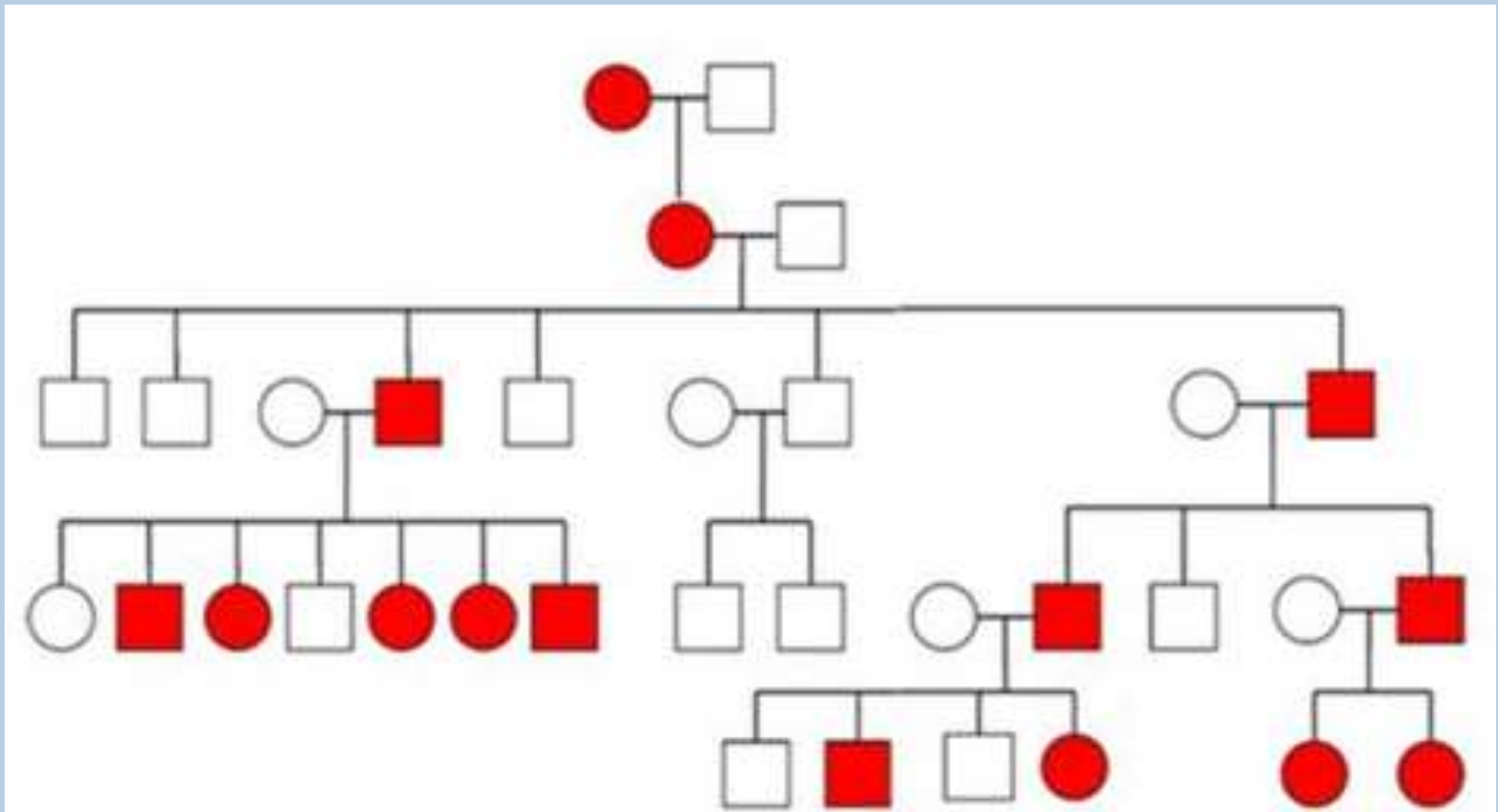
Deciphering Pedigrees



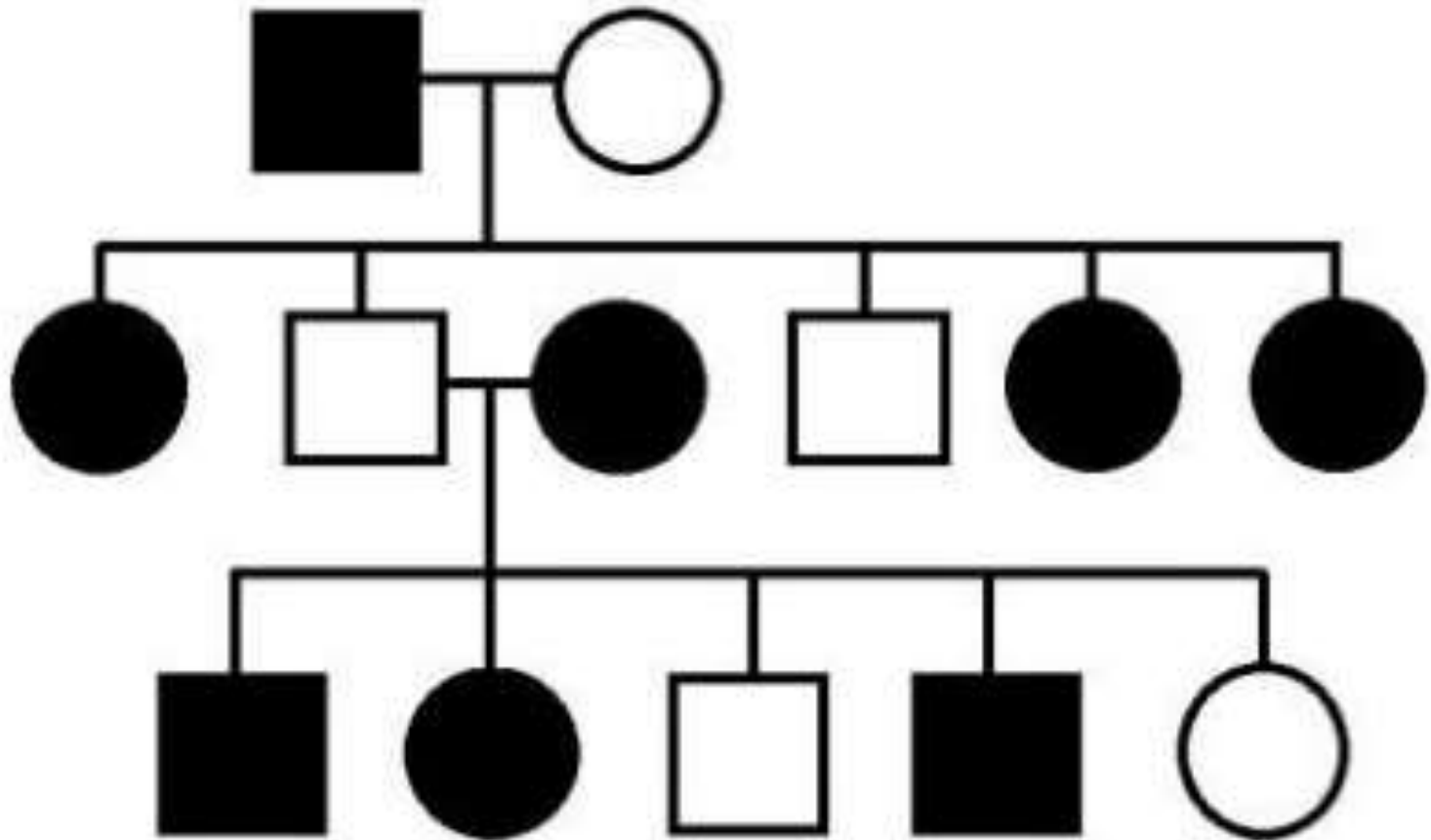
Deciphering Pedigrees



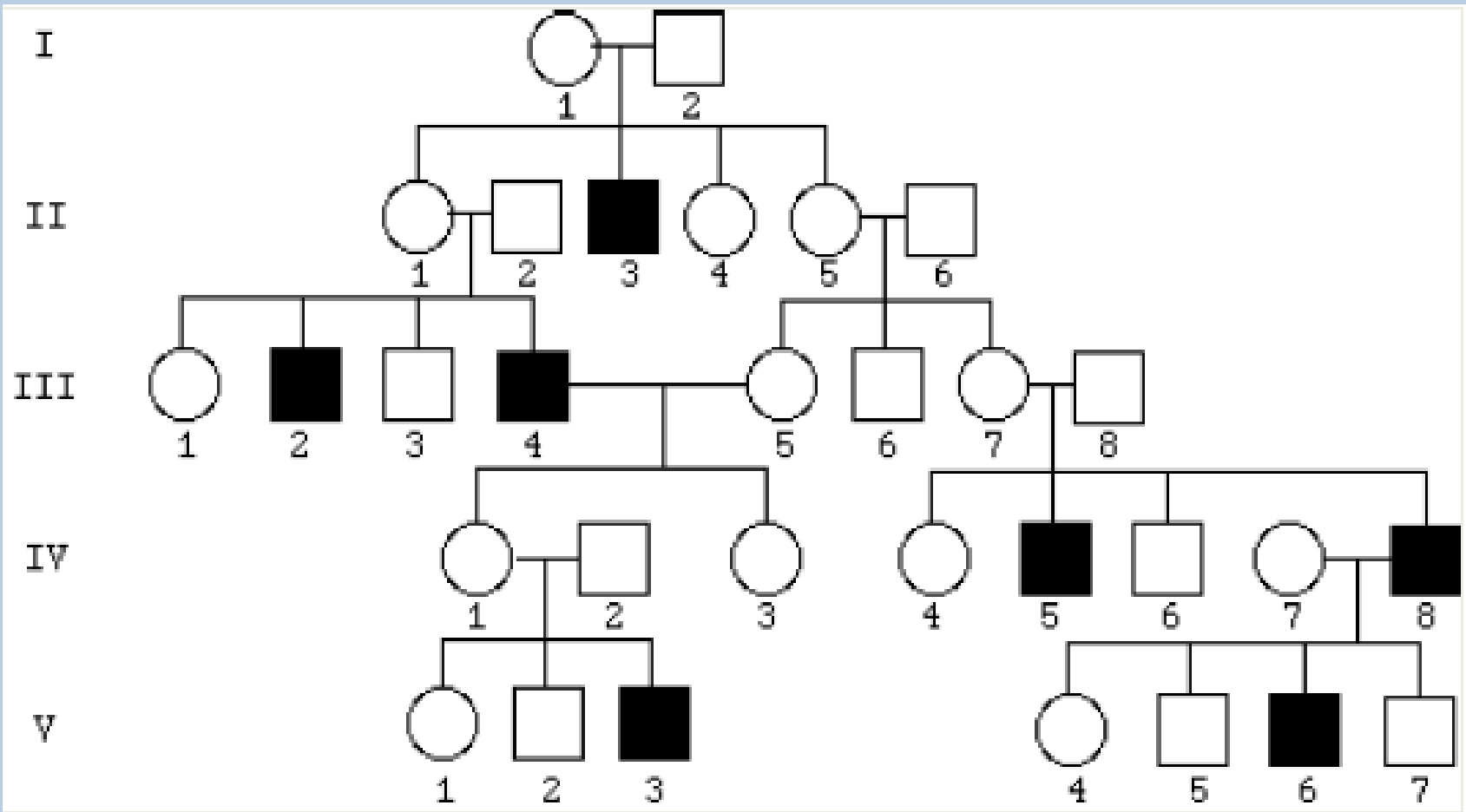
Deciphering Pedigrees



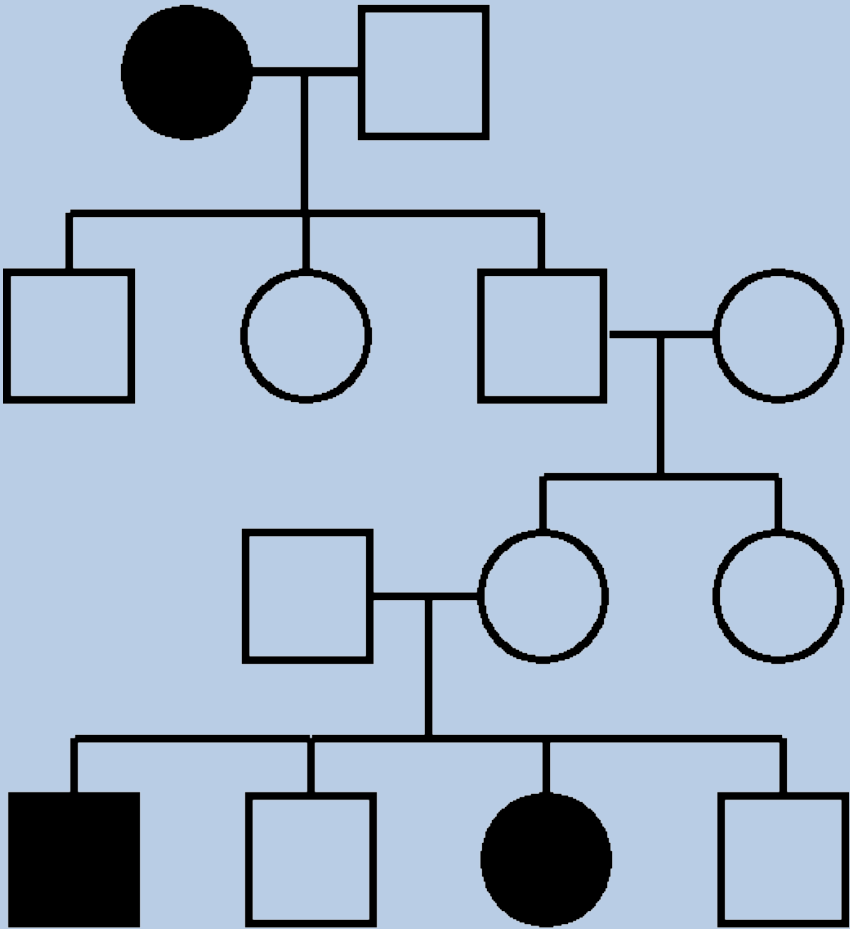
What is the pattern of inheritance?



What is the pattern of inheritance?

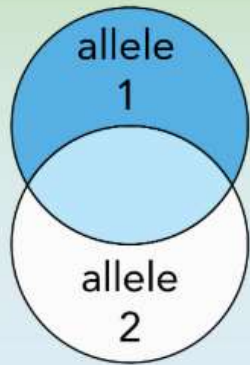


What is the pattern of inheritance?



Picture Quiz

INCOMPLETE DOMINANCE



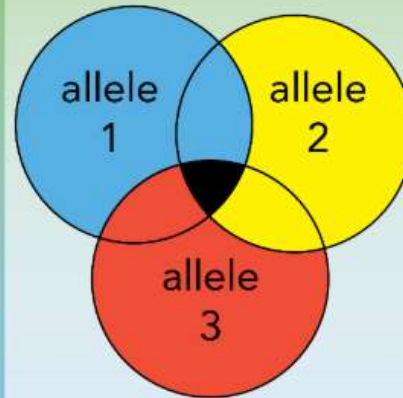
Neither allele is dominant or recessive

CODOMINANCE



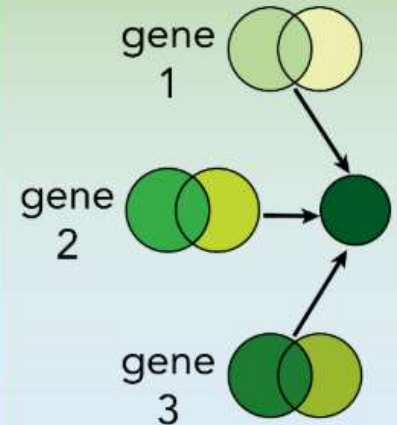
Both alleles are clearly expressed

MULTIPLE ALLELES



One gene has more than two alleles

POLYGENIC TRAITS



More than one gene controls a trait

**Identify the following pictures
using these words:**

- Polygenic trait**
- Incomplete Dominance**
- Codominance**
- Multiple Alleles**



Polygenic Trait





Incomplete Dominance





Codominance





Codominance



Genotype

CC

$c^{ch}c^{ch}$

c^hc^h

cc

Phenotype

BLACK





CHINCHILLA

HIMALAYAN

ALBINO



Multiple Alleles

| Genotype | | | |
|--|--|---|--|
| CC | $c^{ch}c^{ch}$ | $c^h c^h$ | cc |
| Phenotype | | | |
| BLACK | CHINCHILLA | HIMALAYAN | ALBINO |
|  |  |  |  |



Polygenic, Multiple Alleles





X



Incomplete Dominance



X



| | | |
|----------|-----------|-----------|
| | B | B |
| b | Bb | Bb |
| b | Bb | Bb |



CODOMINANCE

This is how it works

Complex Inheritance – pg. 64



Environmental Effects



Environmental Effects



Multiple Alleles

Genotype

CC

$c^{ch}c^{ch}$

$c^h c^h$

cc

Phenotype

BLACK

CHINCHILLA

HIMALAYAN

ALBINO



Polygenic Traits








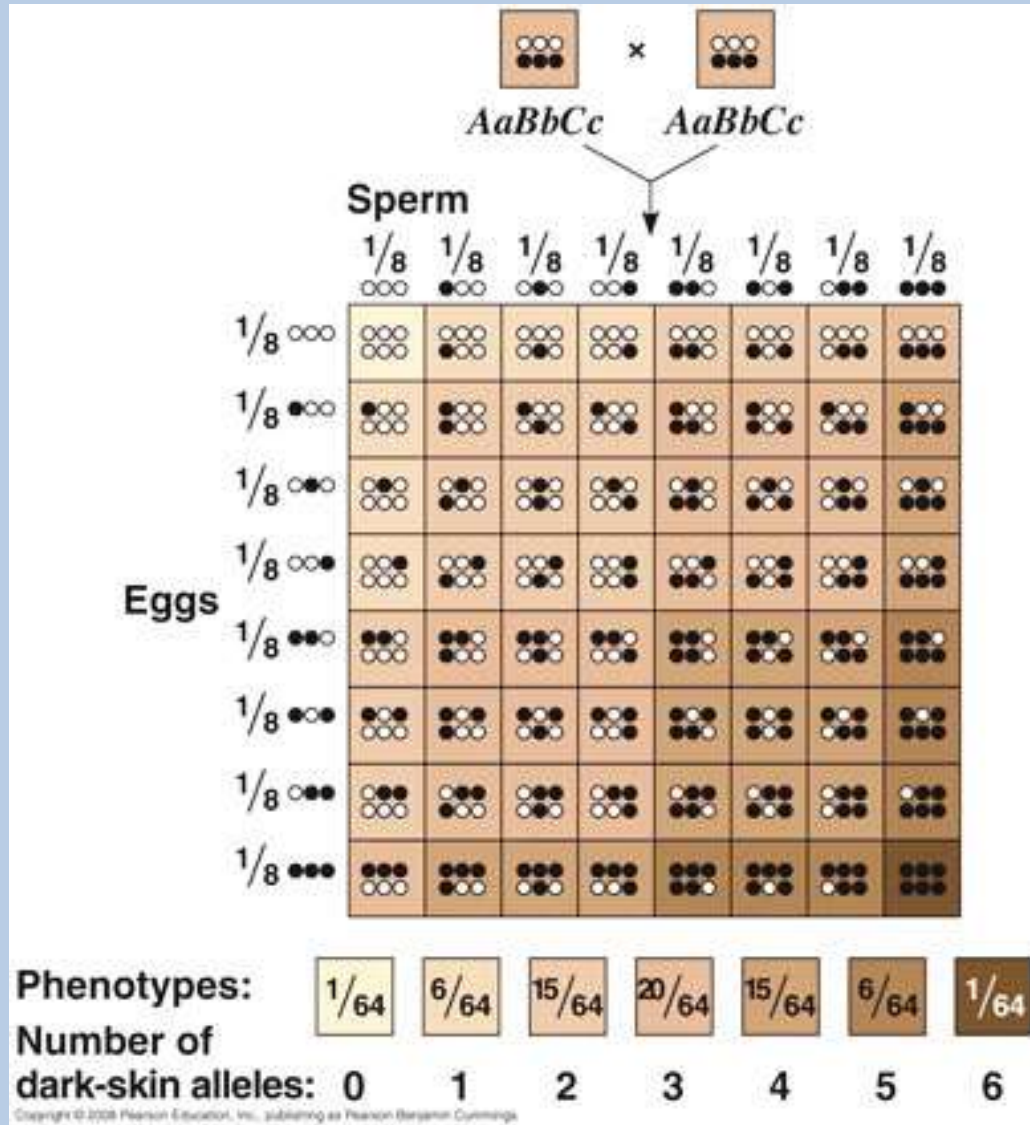
| | | | | | | | |
|---------------------------------|---|---|---|--|---|---|---|
| Gene 1 | d^1d^1 | d^1D^1 | d^1D^1 | D^1D^1 | D^1d^1 | D^1d^1 | D^1D^1 |
| Gene 2 | d^2d^2 | d^2d^2 | d^2D^2 | D^2d^2 | D^2d^2 | D^2D^2 | D^2D^2 |
| Gene 3 | d^3d^3 | d^3d^3 | d^3d^3 | d^3d^3 | D^3D^3 | D^3D^3 | D^3D^3 |
| Total number of dark-skin genes | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| |  |  |  |  |  |  |  |
| | Very light | | | Medium | | | Very dark |
| # of light "d" alleles | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| # of dark "D" alleles | 0 | 1 | 2 | 3 | 4 | 5 | 6 |

FIGURE 10.7 Polygenic Inheritance

Skin color in humans is an example of polygenic inheritance. The dark "D" alleles are found in several different genes and have an additive effect on skin color. The top portion of the figure shows examples of genotypes that can produce the different skin colors. The number of dark "D" alleles is more important than how the "D" alleles are distributed in the different genes.

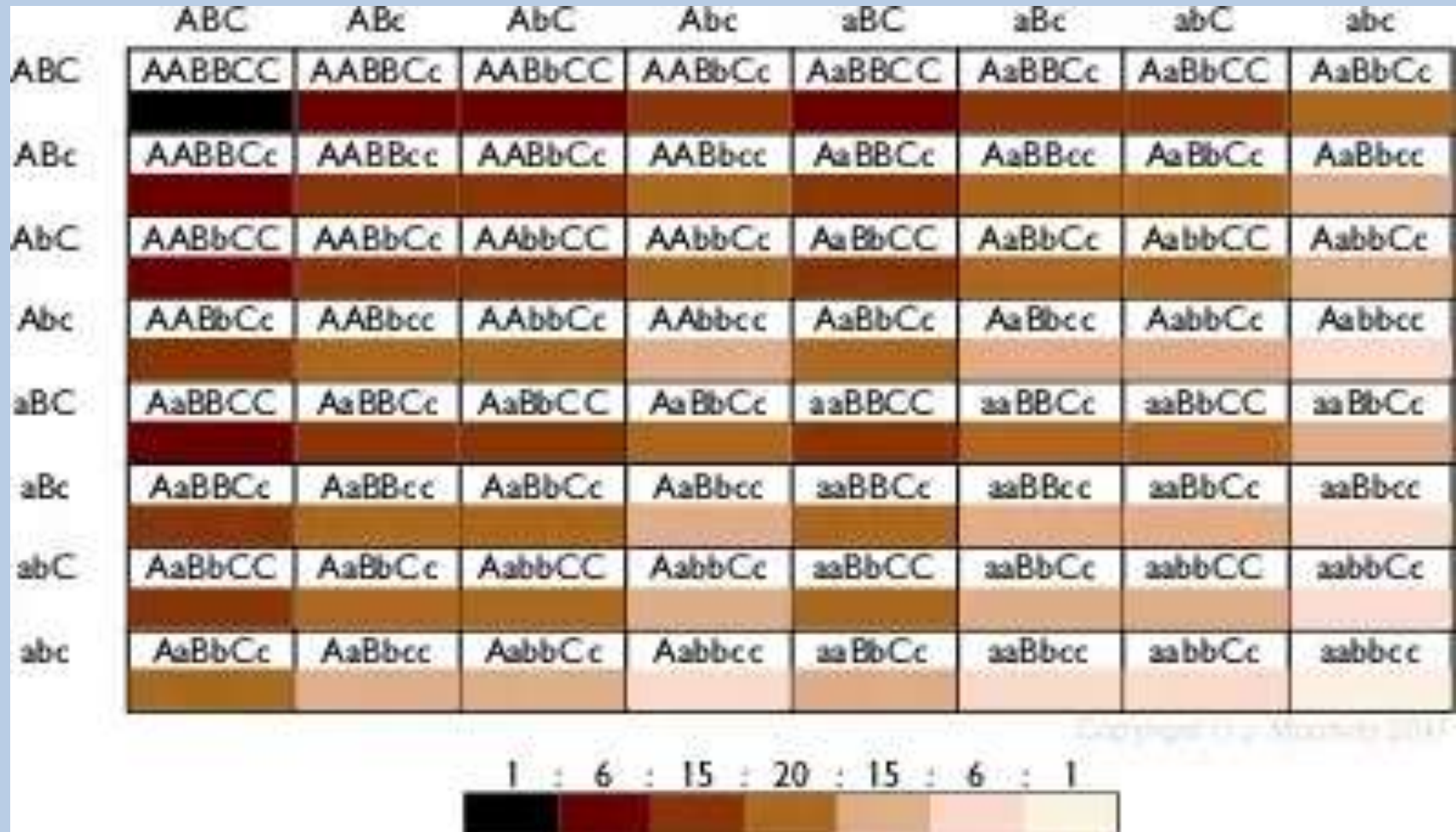
Polygenic Traits



Polygenic Traits

| | | sperm | | | | | | | |
|---------|-----|-------|-----|-----|-----|-----|-----|-----|-----|
| Gametes | | ABC | ABC | AbC | Abc | aBC | aBC | abC | abc |
| eggs | ABC | 6 | 5 | 5 | 4 | 5 | 4 | 4 | 3 |
| | ABC | 5 | 4 | 4 | 3 | 4 | 3 | 3 | 2 |
| | AbC | 5 | 4 | 4 | 3 | 4 | 3 | 3 | 2 |
| | Abc | 4 | 3 | 3 | 2 | 3 | 2 | 2 | 1 |
| | aBC | 5 | 4 | 4 | 3 | 4 | 3 | 3 | 2 |
| | aBC | 4 | 3 | 3 | 2 | 3 | 2 | 2 | 1 |
| | abC | 4 | 3 | 3 | 2 | 3 | 2 | 2 | 1 |
| | abc | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 0 |

Polygenic Traits



Polygenic Traits

| | <i>Sable</i> <i>aw+aw</i> | <i>Sable</i> <i>aw+as</i> | <i>Sable</i> <i>aw+at</i> | <i>Sable</i> <i>aw+a</i> | <i>Blk&Tan</i> <i>as+as</i> | <i>Blk&Tan</i> <i>as+at</i> | <i>Blk&Tan</i> <i>as+a</i> | <i>Bi-Color</i> <i>at+at</i> | <i>Bi-Color</i> <i>at+a</i> | <i>Black</i> <i>a+a</i> |
|------------------------------------|------------------------------|--|--|--|------------------------------------|--|--|---------------------------------|--|----------------------------|
| <i>Sable</i> <i>aw+aw</i> | 100% aw+aw | 50% aw+aw 50% aw+as | 50% aw+aw 50% aw+at | 50% aw+aw 50% aw+a | 100% aw+as | 50% aw+as 50% aw+at | 50% aw+as 50% aw+a | 100% aw+at | 50% aw+at 50% aw+a | 100% aw+a |
| <i>Sable</i> <i>aw+as</i> | 50% aw+aw 50% aw+as | 50% aw+as 25% aw+aw 25% [as+aw] | 25% aw+aw 25% aw+as 25% [as+at] | 25% aw+aw 25% aw+as 25% [as+a] | 50% aw+as 50% as+as | 25% aw+as 25% aw+at 25% as+at | 25% aw+as 25% aw+a 25% as+a | 50% aw+at 50% [as+at] | 25% aw+at 25% aw+a 25% [as+at] 25% [as+a] | 50% aw+a 50% [as+a] |
| <i>Sable</i> <i>aw+at</i> | 50% aw+aw 50% aw+at | 25% aw+aw 25% aw+as 25% [as+at] | 50% aw+at 25% aw+aw 25% [at+at] | 25% aw+at 25% aw+a 25% [at+a] | 50% aw+as 50% as+at | 25% aw+as 25% aw+at 25% as+at | 25% aw+as 25% aw+a 25% as+a | 50% aw+at 50% at+at | 25% aw+at 25% aw+a 25% at+at 25% at+a | 50% aw+a 50% [at+a] |
| <i>Sable</i> <i>aw+a</i> | 50% aw+aw 50% aw+a | 25% aw+aw 25% aw+as 25% [as+a] | 25% aw+aw 25% aw+at 25% [at+a] | 50% aw+a 25% aw+aw 25% [a+a] | 50% aw+as 50% as+as | 25% aw+as 25% aw+at 25% as+a | 25% aw+as 25% aw+a 25% as+a | 50% aw+at 50% at+a | 25% aw+at 25% aw+a 25% at+a | 50% aw+a 50% a+a |
| <i>Blk&Tan</i> <i>as+as</i> | 100% aw+as | 50% aw+as 50% as+as | 50% aw+as 50% as+at | 50% aw+as 50% as+a | 100% as+as | 50% as+as 50% as+at | 50% as+as 50% as+a | 100% as+at | 50% as+at 50% as+a | 100% as+a |
| <i>Blk&Tan</i> <i>as+at</i> | 50% aw+as 50% aw+at | 25% aw+as 25% aw+at 25% as+at | 25% aw+as 25% aw+at 25% as+at 25% [at+at] | 25% aw+as 25% aw+at 25% as+a 25% [at+a] | 50% as+as 50% as+at | 25% as+at 25% as+at 25% [at+at] | 25% as+at 25% as+a 25% [at+a] | 50% as+at 50% at+at | 25% as+at 25% as+a 25% at+at 25% at+a | 50% as+a 50% [at+a] |
| <i>Blk&Tan</i> <i>as+a</i> | 50% aw+as 50% aw+a | 25% aw+as 25% aw+a 25% as+a | 25% aw+as 25% aw+at 25% as+at 25% [at+a] | 25% aw+as 25% aw+a 25% as+a 25% [a+a] | 50% as+as 50% as+a | 25% as+at 25% as+a 25% [at+a] | 50% as+a 25% [a+a] | 50% as+at 50% at+a | 25% as+at 25% as+a 25% at+a 25% [a+a] | 50% as+a 50% a+a |
| <i>Bi-Color</i> <i>at+at</i> | 100% aw+at | 50% aw+at 50% [as+at] | 50% aw+at 50% at+at | 50% aw+at 50% at+a | 100% as+at | 50% as+at 50% at+at | 50% as+at 50% at+a | 100% at+at | 50% at+at 50% at+a | 100% at+a |
| <i>Bi-Color</i> <i>at+a</i> | 50% aw+at 50% aw+a | 25% aw+at 25% aw+a 25% [as+at] 25% [as+a] | 25% aw+at 25% aw+at 25% at+at 25% at+a | 25% aw+at 25% aw+a 25% at+a 25% [a+a] | 50% as+at 50% as+a | 25% as+at 25% as+a 25% at+at 25% at+a | 25% as+at 25% as+a 25% at+a 25% [a+a] | 50% at+at 50% at+a | 25% at+at 25% at+a 25% [a+a] | 50% at+a 50% a+a |
| <i>Black</i> <i>a+a</i> | 100% aw+a | 50% aw+a 50% [as+a] | 50% aw+a 50% [at+a] | 50% aw+a 50% a+a | 100% as+a | 50% as+a 50% [at+a] | 50% as+a 50% a+a | 100% at+a | 50% at+a 50% a+a | 100% a+a |

Polygenic Traits



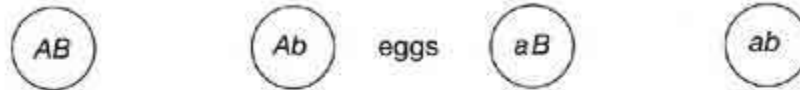
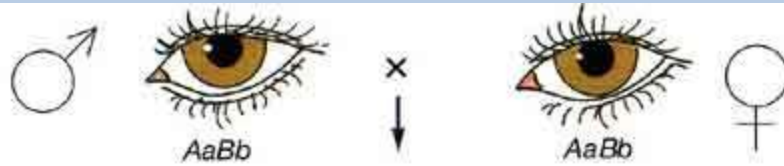
Polygenic Traits



Polygenic Traits

| <i>HERC2</i> | <i>Gey</i> | Eye Color |
|--------------|------------|-----------|
| BB | GG | Brown |
| BB | Gb | Brown |
| BB | bb | Brown |
| Bb | GG | Brown |
| Bb | Gb | Brown |
| Bb | bb | Brown |
| bb | GG | Green |
| bb | Gb | Green |
| bb | bb | Blue |

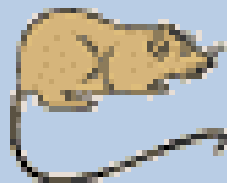
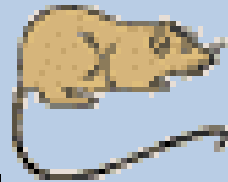
| | B/G | B/g | b/G | b/g |
|-----|---------|---------|---------|---------|
| B/G | ■ BB/GG | ■ BB/Gg | ■ Bb/GG | ■ Bb/Gg |
| B/g | ■ BB/Gg | ■ BB/gg | ■ Bb/Gg | ■ Bb/gg |
| b/G | ■ Bb/GG | ■ Bb/Gg | ■ bb/GG | ■ bb/Gg |
| b/g | ■ Bb/Gg | ■ Bb/gg | ■ bb/Gg | ■ bb/gg |



















| | | | | | | |
|-------|----|-----------------|-----------------|-----------------|-----------------|------------------------|
| sperm | AB | <i>AABB</i> | <i>AABb</i> | <i>AaBB</i> | <i>AaBb</i> | light blue |
| | Ab | <i>AABb</i> | <i>AAbb</i> | <i>AaBb</i> | <i>Aabb</i> | deep blue or green |
| | aB | <i>AaBB</i> | <i>AaBb</i> | <i>aaBB</i> | <i>aaBb</i> | light brown |
| | ab | <i>AaBb</i> | <i>Aabb</i> | <i>aaBb</i> | <i>aabb</i> | dark brown/black |

Epistasis

AaBb X AaBb



| | AB | Ab | aB | ab | |
|----|---|---|---|---|----------|
| AB | AABB  | AABb  | AaBB  | AaBb  | 9 agouti |
| Ab | AABb  | AAbb  | AaBb  | Aabb  | |
| aB | AaBB  | AaBb  | aaBB  | aaBb  | 4 albino |
| ab | AaBb  | Aabb  | aaBb  | aabb  | |

Epistasis



Epistasis



B_E_



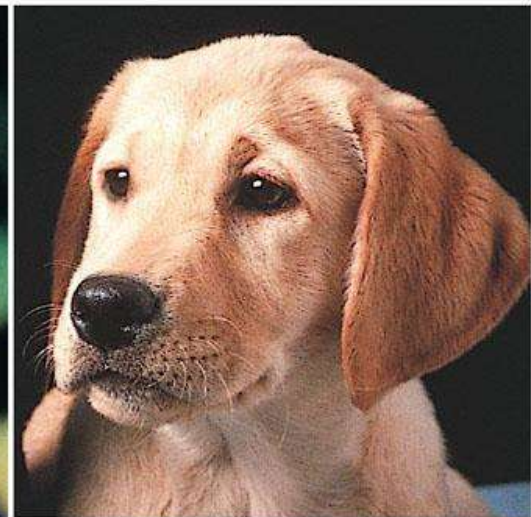
bb_E_



__ ee




Epistasis

| | EB | Eb | eB | eb |
|------|-----------------|---------------------|------------------|---------------------|
| EB | $EEBB$ black | $EEBb$ black | $EeBB$ black | $EeBb$ black |
| Eb | $EEBb$ black | $EEbb$ chocolate | $EeBb$ black | $Eebb$ chocolate |
| eB | $EeBB$ black | $EeBb$ black | $eeBB$ yellow | $eeBb$ yellow |
| eb | $EeBb$ black | $Eebb$ chocolate | $eeBb$ yellow | $eebb$ yellow |

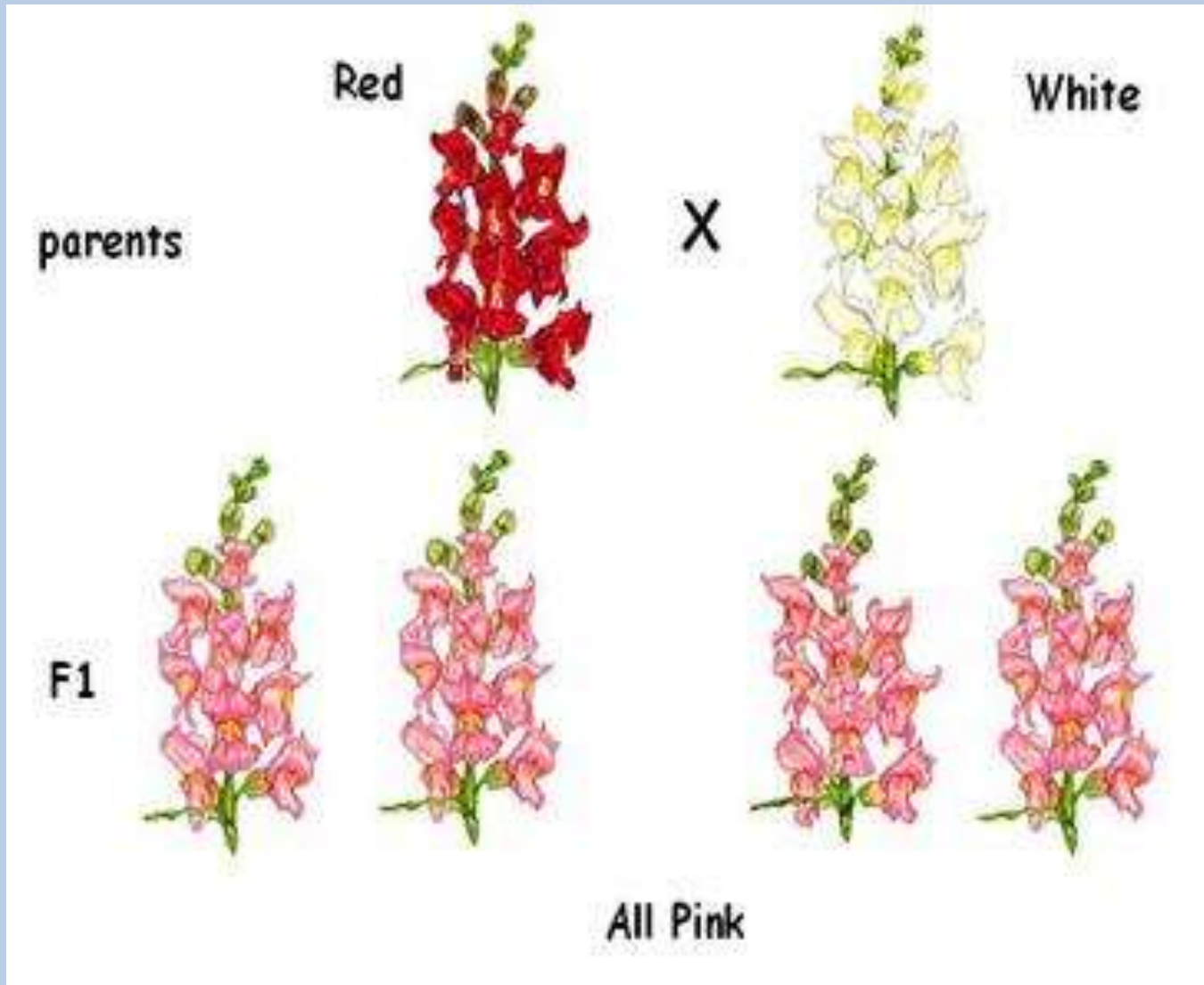


Incomplete Dominance

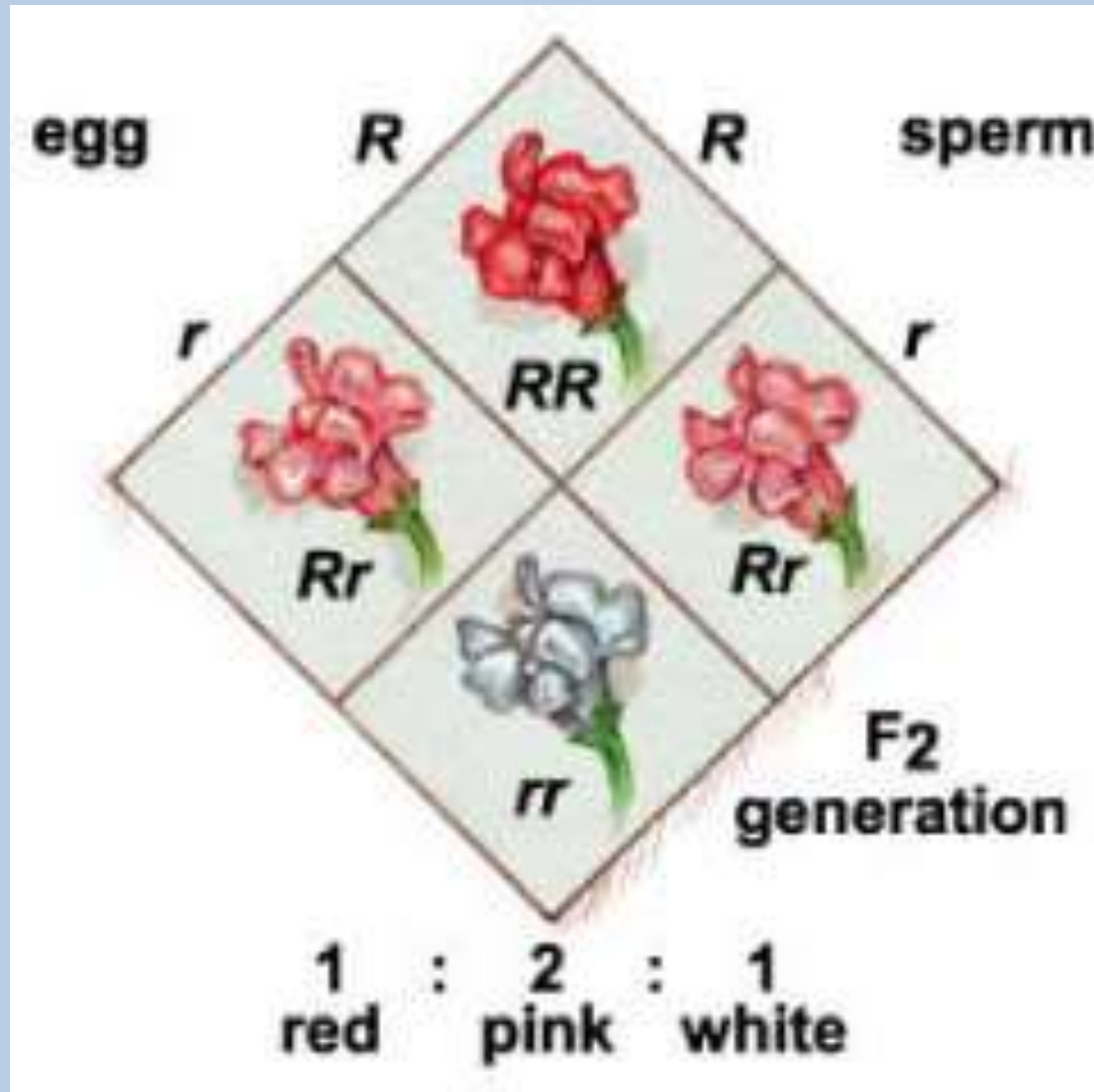
FIGURE 7.5 Incomplete Dominance

| PHENOTYPE | GENOTYPE | PHENOTYPE | GENOTYPE | PHENOTYPE | GENOTYPE |
|---|----------|---|----------|--|----------|
| green | B_1B_1 | steel blue | B_2B_2 | royal blue | B_1B_2 |
|  | |  | |  | |
| The green betta fish is homozygous for the green color allele. | | The steel blue betta fish is homozygous for the blue color allele. | | The royal blue betta fish is heterozygous for the two color alleles. | |

Incomplete Dominance



Incomplete Dominance



Codominance

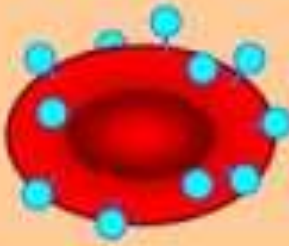

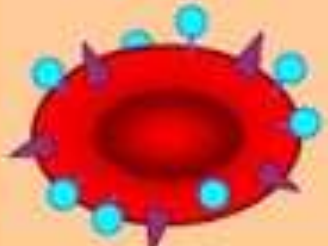


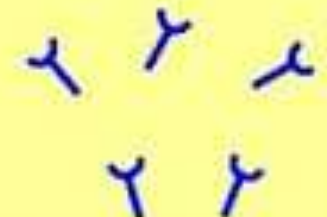
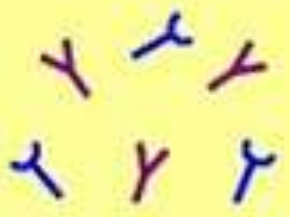


both equally present



mixing

Blood Type

| ABO Blood Groups | | | | |
|--------------------------------|--|---|---|--|
| Antigen (on RBC) | Antigen A  | Antigen B  | Antigens A + B  | Neither A or B  |
| Antibody (in plasma) | Anti-B Antibody  | Anti-A Antibody  | Neither Antibody | Both Antibodies  |
| Blood Type | Type A Cannot have B or AB blood Can have A or O blood | Type B Cannot have A or AB blood Can have B or O blood | Type AB Can have any type of blood Is the universal recipient | Type O Can only have O blood Is the universal donor |

Blood Type

| Phenotype (Blood type) | Genotype |
|---------------------------|----------------------------|
| Type A | $I^A I^A$ or $I^A i$ |
| Type B | $I^B I^B$ or $I^B i$ |
| Type AB | $I^A I^B$ |
| Type O | $i i$ |

Complex Inheritance Problems

**Today you will practice
using these concepts.**

Complex Inheritance

- **TAKE YOUR TIME**
- **Answer the questions carefully**
- **Be THOROUGH in your explanations**

Blood Type

| Phenotype (Blood type) | Genotype |
|---------------------------|----------------------------|
| Type A | $I^A I^A$ or $I^A i$ |
| Type B | $I^B I^B$ or $I^B i$ |
| Type AB | $I^A I^B$ |
| Type O | $i i$ |