Topic 1:
Cracking the Mystery of Heredity

Sssshhhhh … listen to the pea plants

Genetics

The study of heredity, how traits are passed from parent to offspring

X

=

or

or

- The details of heredity remained a **mystery** for many years
- Many thought the parents' traits **blended** in the next generation … much like mixing red and white paint to get pink

- Can you think of any human traits that are NOT inherited in this way???

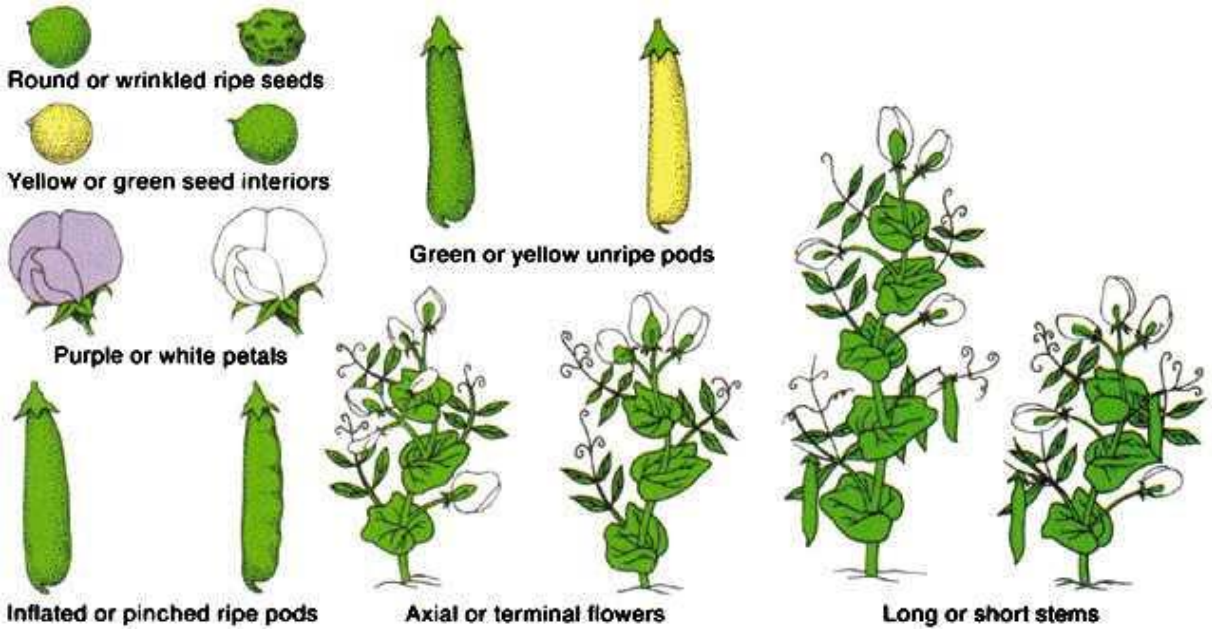
- The first person to begin solving the mystery of heredity in the 1800s was an Austrian monk named **Gregor Mendel**

"Father of Genetics"

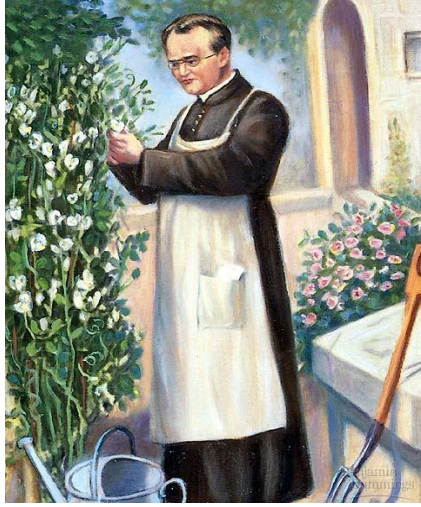
Mendel's Experiments

- Mendel's understanding of heredity came from several years observing how traits are inherited in **pea plants**

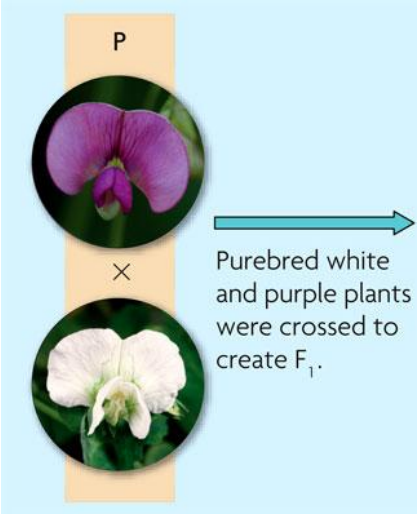
- He chose to follow 7 simple traits that occur in 2 **opposite** forms through 2 generations of breeding experiments.



Mendel's Experiments



- Mendel's experiments began by **hand** cross-pollinating parent plants (P generation) that breed **pure** generation after generation for 2 opposite forms of a trait
- (e.g. **purple** flowers x **white** flowers)



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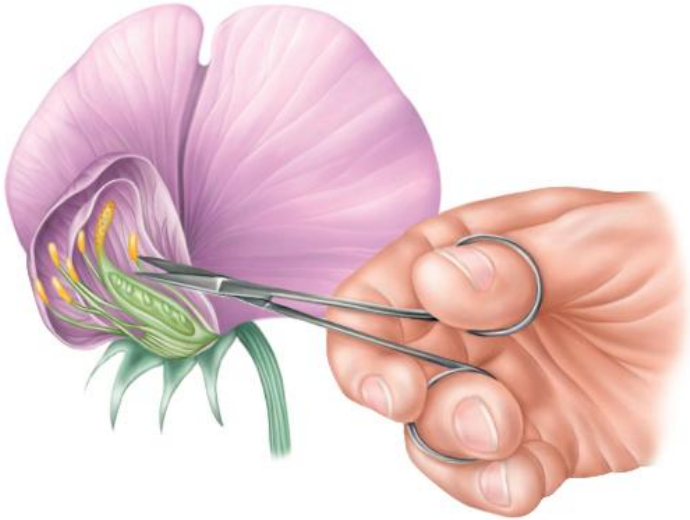
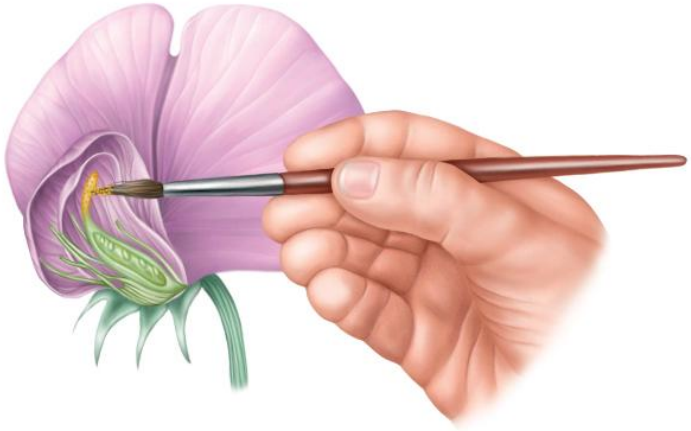
6.3 Mendel and Heredity

- Mendel used pollen to fertilize selected pea plants.
  - P generation crossed to produce F_1 generation
  - interrupted the self-pollination process by removing male flower parts



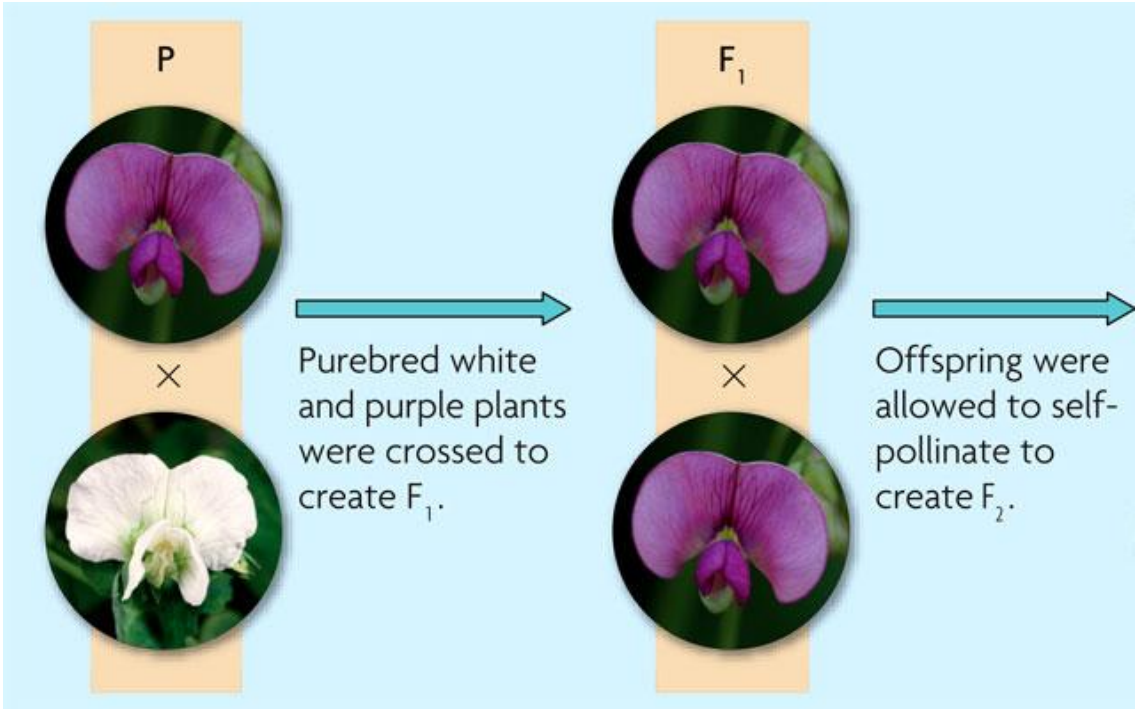
Mendel controlled the fertilization of his pea plants by removing the male parts, or stamens.



He then fertilized the female part, or pistil, with pollen from a different pea plant.

6.3 Mendel and Heredity

- The next generation (F_1) had all **purple** flowers
- Mendel wondered what had happened to the **white** trait???
- He allowed the purple flowered F_1 generation to **self**-pollinate the next generation to see what would happen?



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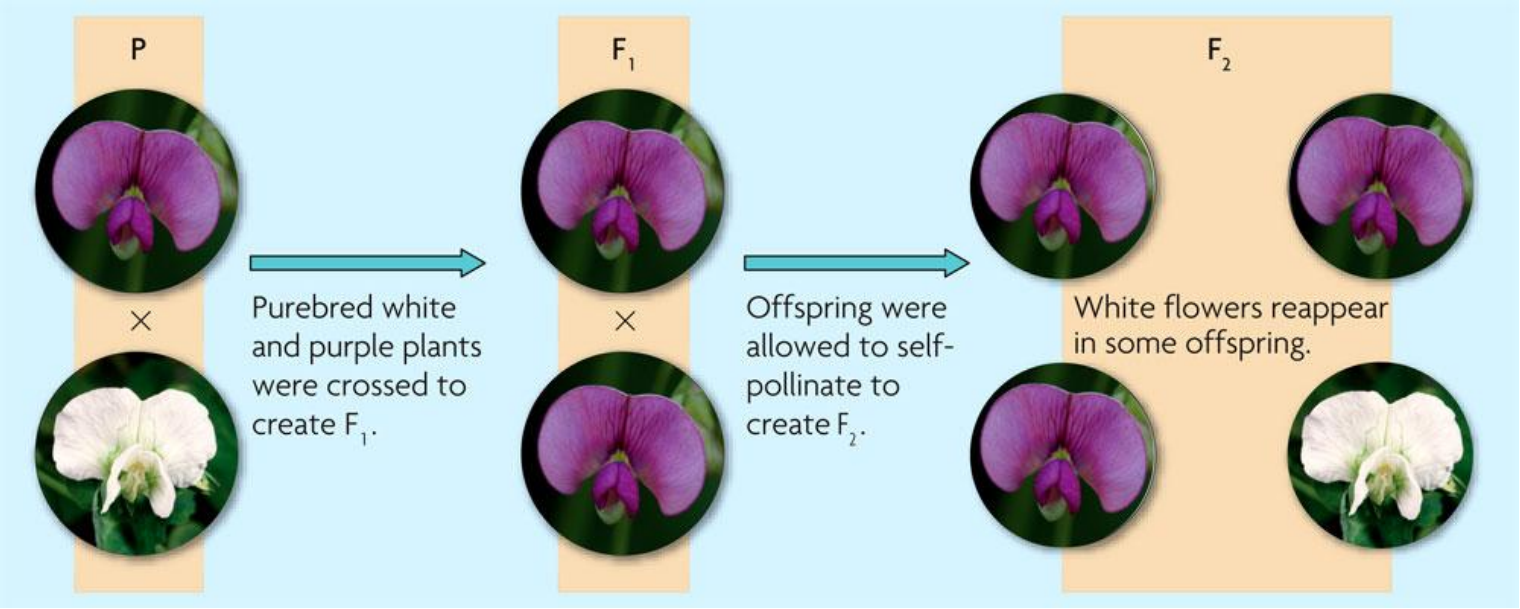
6.3 Mendel and Heredity

- The second generation (F_2) had many purple flowers but some **white** flowers…..HOW???
- Mendel suggested that each pea plant trait is determined by inheriting **2** gene codes, one from each parent
- Mendel was the first to crack this inheritance mystery when he proposed that one gene code is **Dominant** and the other gene code is **recessive** and remains "hidden" unless both genes are recessive



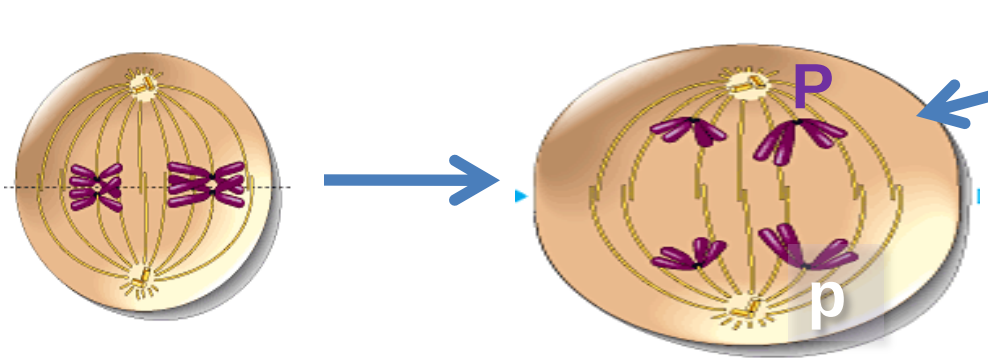
6.3 Mendel and Heredity

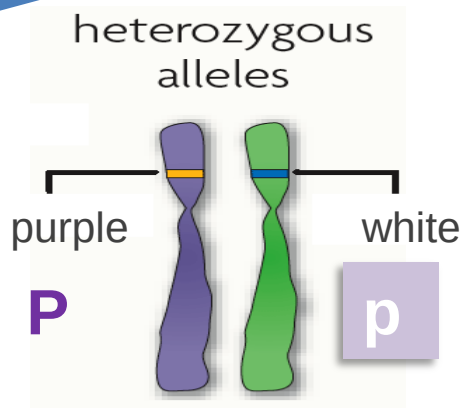
- Mendel repeated his experiment for other traits and noticed **patterns** in the first and second generations of his crosses.
- Do **YOU** notice any patterns in his F_2 data below ???

FIGURE 6.10 MENDEL'S MONOHYBRID CROSS RESULTS			
F_2 TRAITS	DOMINANT	RECESSIVE	RATIO
Pea shape	5474 round	1850 wrinkled	2.96:1
Pea color	6022 yellow	2001 green	3.01:1
Flower color	705 purple	224 white	3.15:1
Pod shape	882 smooth	299 constricted	2.95:1
Pod color	428 green	152 yellow	2.82:1
Flower position	651 axial	207 terminal	3.14:1
Plant height	787 tall	277 short	2.84:1

6.3 Mendel and Heredity

- Mendel wondered why the recessive trait consistently seemed to **hide** during the F_1 generation but then reappeared in the F_2 generation only **1/4th** of the time???
- He reasoned that this consistent **3:1** ratio in the traits follows the rules of math **probability**. This means that each time a parent creates a gamete, they must randomly send only 1 of their 2 gene codes just like **flipping a coin**. Today we understand why Mendel's "coin toss" idea was correct because we can see the two genes move in opposite directions during Anaphase 1 of **Meiosis**.



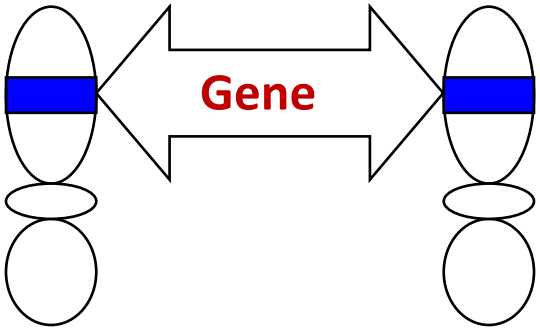


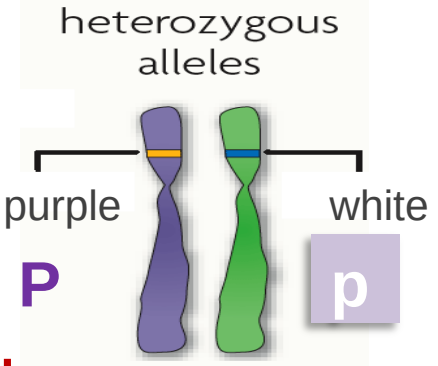
Mendel's Legacy

- Mendel's legacy is that his work laid the **foundation** for understanding heredity
- His ideas about heredity correctly explain how many traits are inherited, not only for pea plants, but also for all sexually reproducing organisms from insects to **humans**.

Punnett Squares
AND
Human Inherited Disorders

Topic 2: Inheritance TERMS





- **Gene**: a segment of DNA or a chromosome "_____" with coded information for a particular trait or characteristic. Because animals are _____(i.e., chromosomes in homologous pairs), there are 2 gene "Mailboxes" for each trait…one inherited from each _____.

  Mailbox
  diploid
  parent

- **Allele**: Actual DNA "_____" or N-base codes found in the gene "Mailbox". One allele is inherited from each parent for each genetic _____.

  letters
  trait

  – Ex: Gene = repair enzyme; Alleles = broken vs normal

- **Gene Notation**: letters are used to represent _____.

  traits

  Rule: ___ letter for each trait

  1

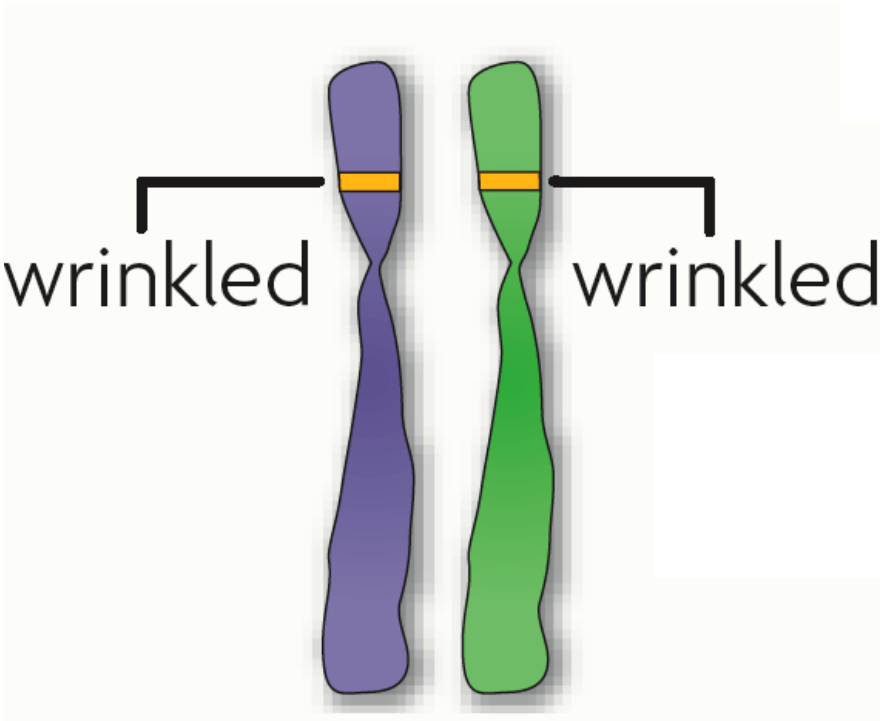
- **Dominant**: alleles which hide or mask the information carried by _recessive_ alleles. Notation = _CAPITAL_ letters
  - Ex: _R_ = normal repair enzyme allele

- **Recessive**: alleles which are only expressed or observed when _NOT_ paired with a Dominant allele (i.e., need _2_ recessive alleles to observe the trait. Notation = _lowercase_ letters
  - Ex: _r_ = broken repair enzyme allele
- **Genotype**: the _2_ alleles inherited for each genetic trait → the actual genetic info.
  - **Homozygous**: 2 copies of the _same_ allele for a trait. Ex: **RR** or **rr**
  - **Heterozygous**: 2 _different_ alleles for a trait Ex: **Rr**

- **Phenotype**: physical appearance of the expressed trait which can be _seen_.
  - Ex: have the _disease_ or are normal and symptom free?
    (i.e., sick or healthy?)

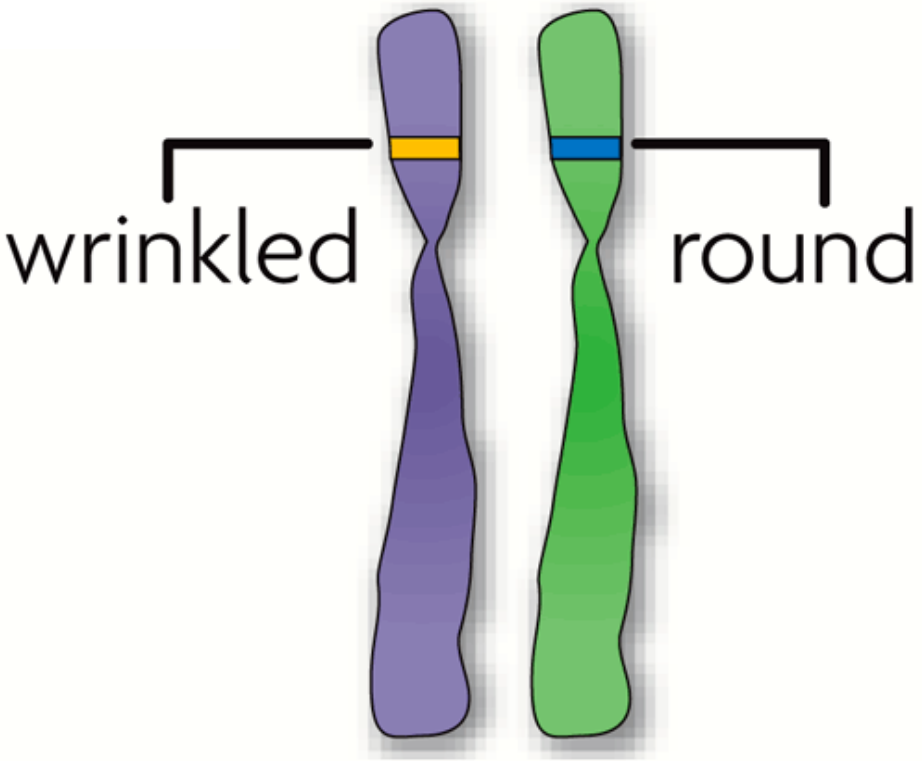
Let's Review

- Homozygous or heterozygous?



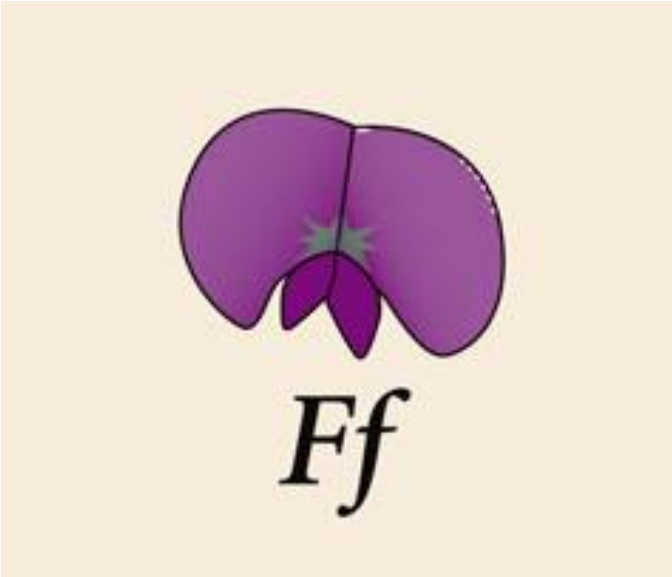
Let's Review

- Homozygous or heterozygous?



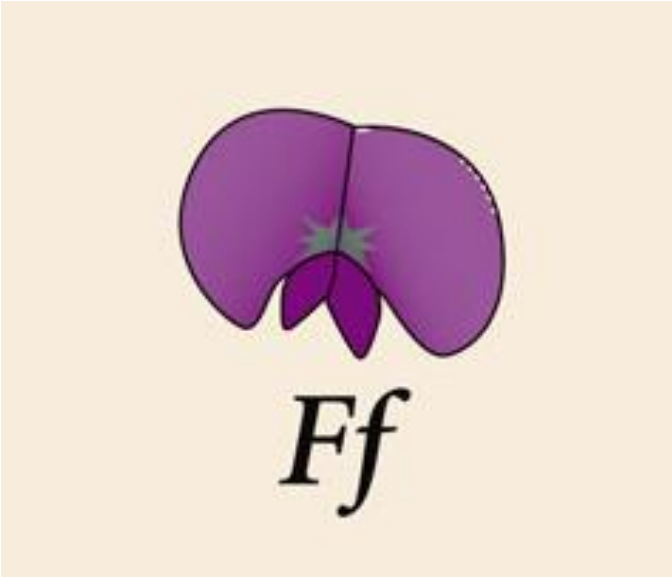
Let's Review

- What is this flower's **genotype**?



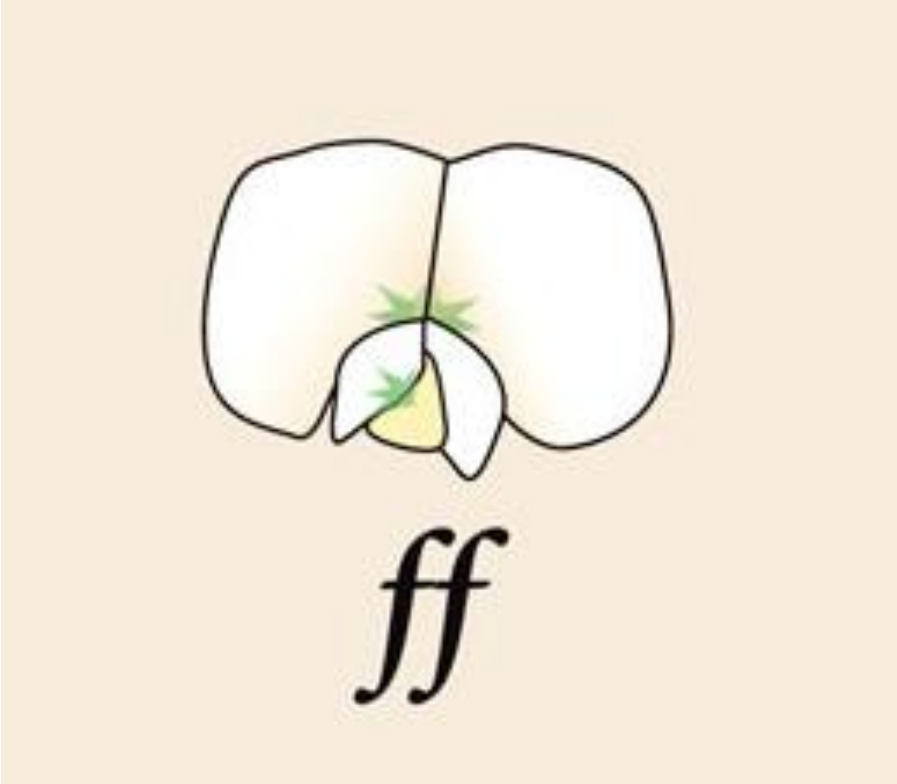
Let's Review

- What is this flower's **phenotype**?



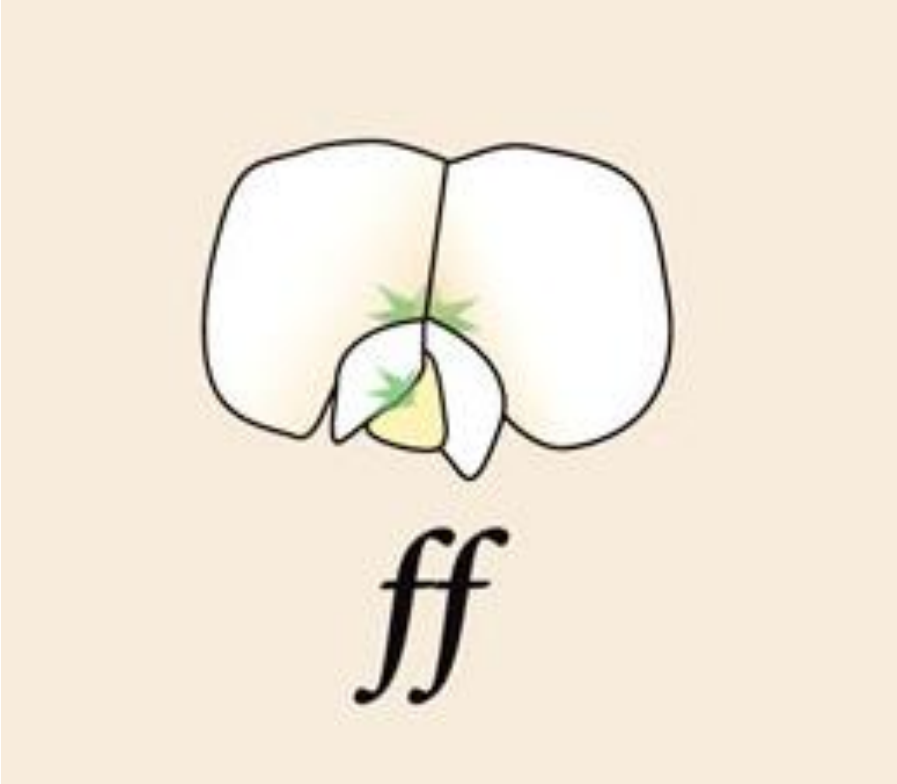
Let's Review

- What is this flower's **phenotype**?



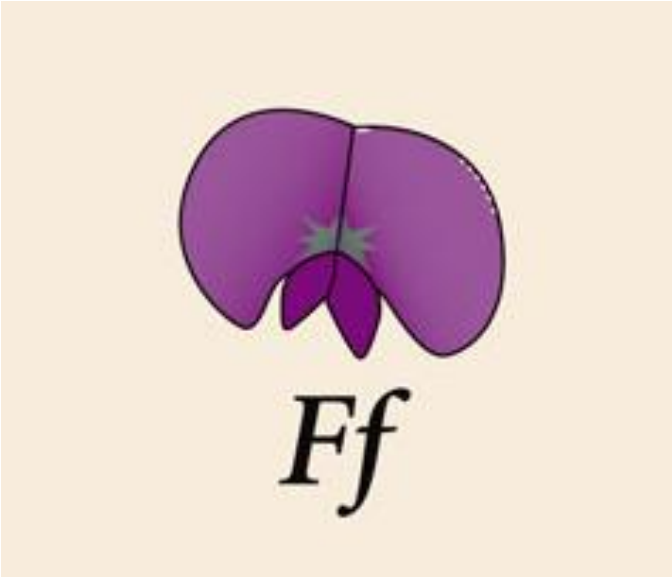
Let's Review

- What is this flower's **genotype**?



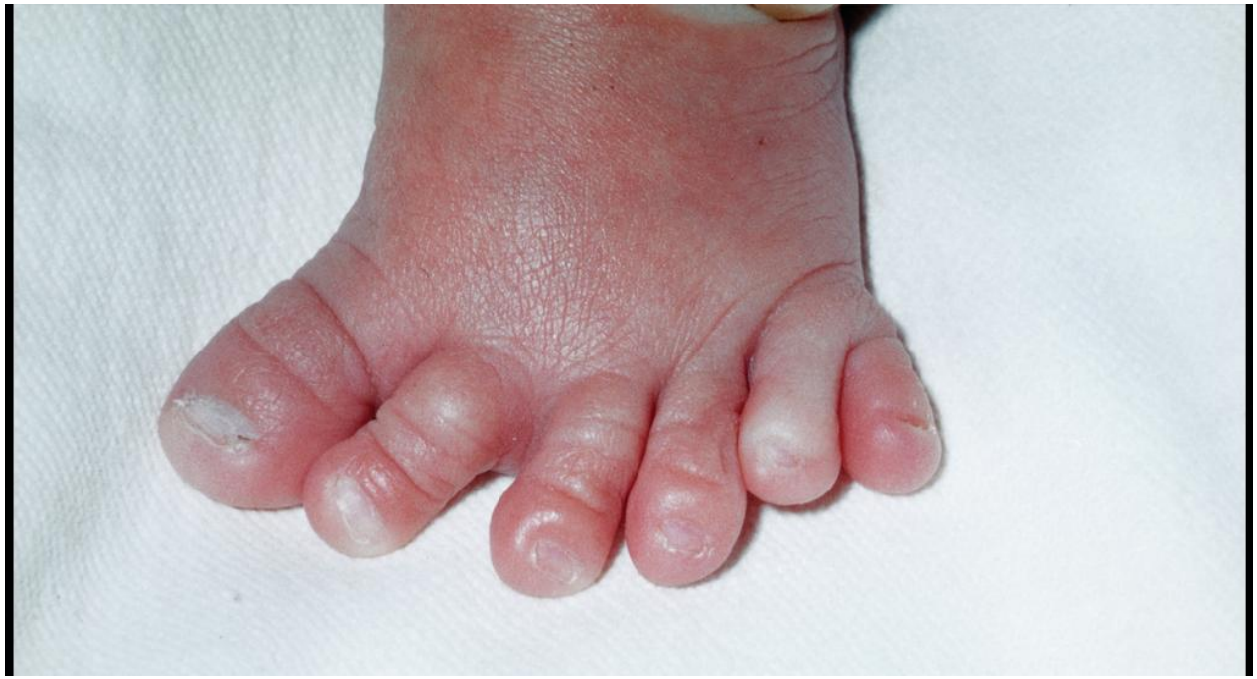
Let's Review

- Is this flower **homozygous or heterozygous**?

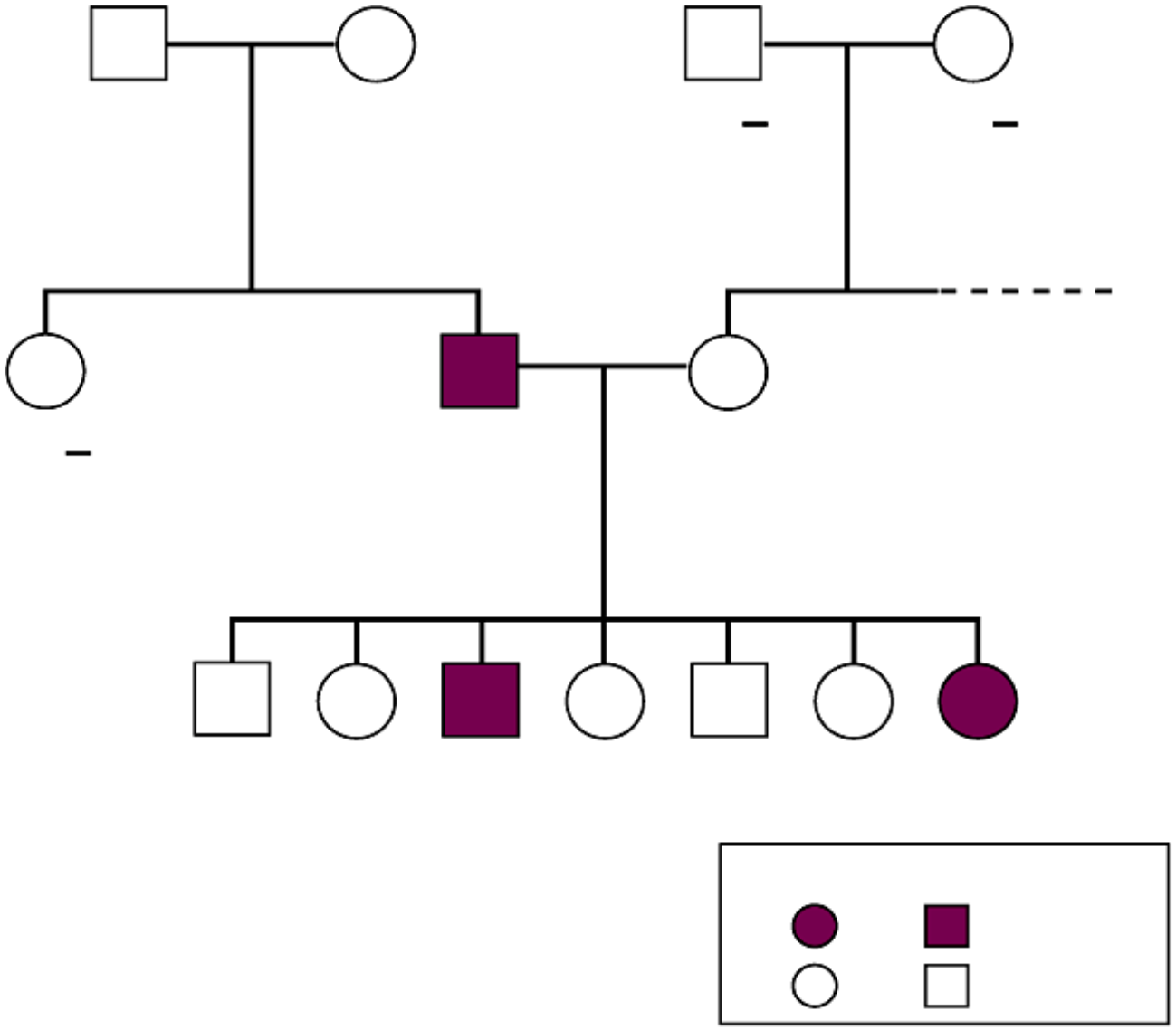


CAUTION

- Dominant alleles are usually frequently seen traits, but they are **not necessarily always common** in the gene pool
- Example = **Polydactyly** in humans (extra digits) is a **dominant** allele

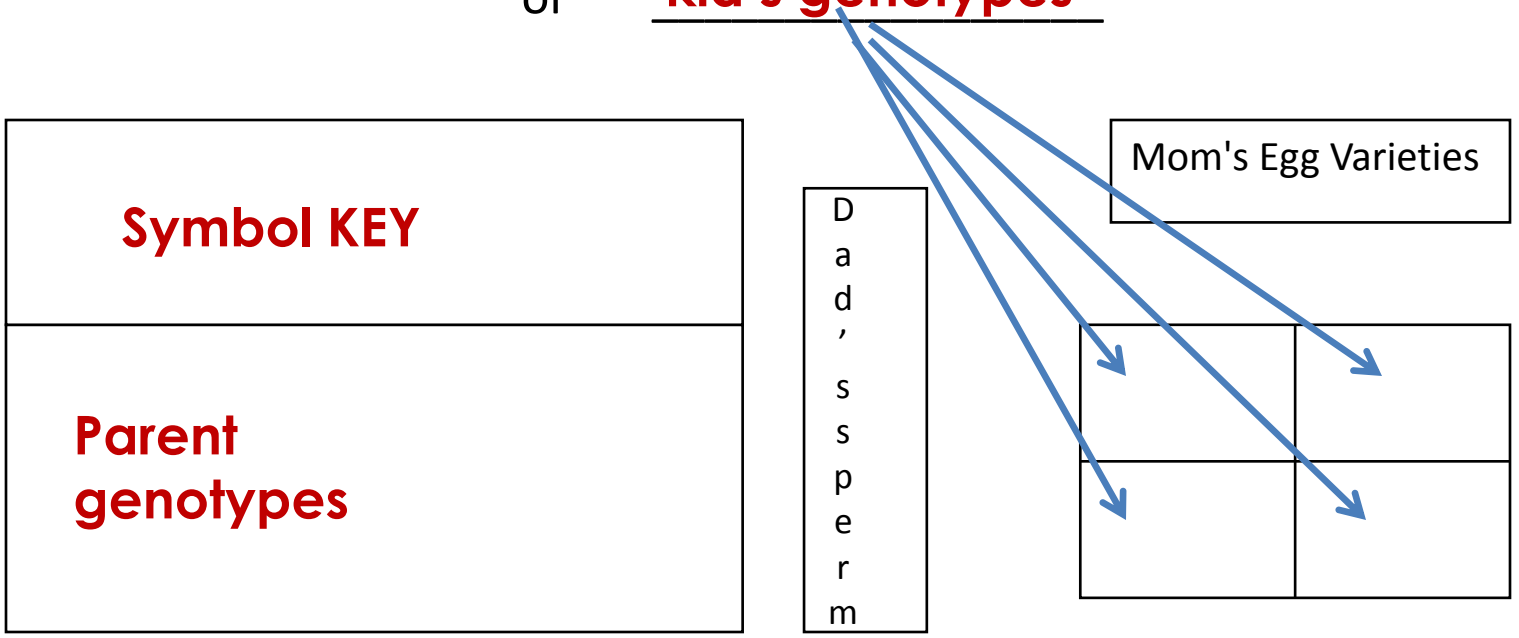


- **Pedigree**: a family _tree_ picture showing how a certain trait is inherited over several _generations_



- **Punnett square**: a box like diagram used to predict the **probability** of expected outcomes for a genetic cross

- Punnett square **Quick Tips**:
  - Define your Dominant & recessive letter symbols: make a key
  - Write each Parent's **genotype**
  - Fill in Mom's egg and Dad's sperm **varieties** along the PS sides
  - Complete the PS boxes to see all the possible genetic cross outcomes
    or **kid's genotypes**



Topic 3: ONE-Trait Crosses

- The inheritance of many **human traits** follows Mendel's principles and the rules of probability

Figure 9.8A

A **Punnett Square** can predict the chances for inheriting a variety of simple human traits

Example 1: What is the chance that a child will have freckles if **DAD** is homozygous for freckles and **MOM** does not have freckles? **4/4**

Gene Notation Symbols Used

F = Freckles

f = NO freckles

Parent Genotypes:

MOM ff

DAD FF

	f	f
F	Ff	Ff
F	Ff	Ff

A **Punnett Square** can predict the chances for inheriting a variety of simple human traits

Example 2: What is the chance that a child will have a straight hairline if **DAD** is heterozygous for widow's peak and **MOM** has a straight hairline? **2/4**

Gene Notation Symbols Used

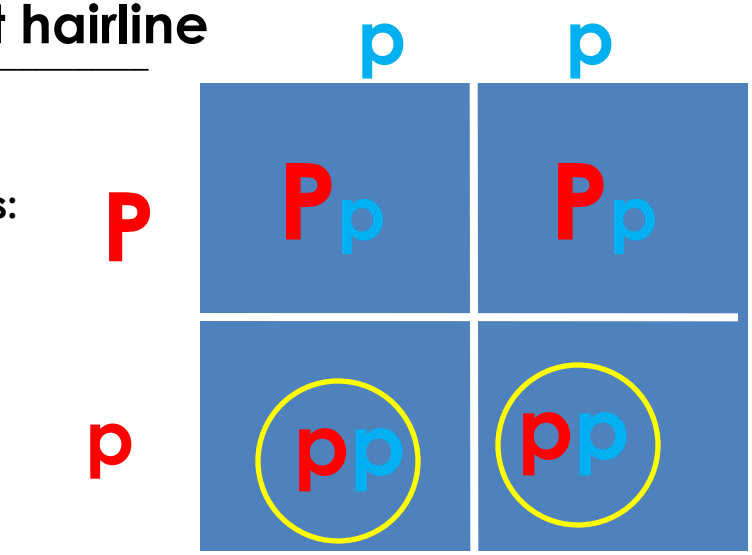
P = **Widow's Peak**

p = **Straight hairline**

Parent Genotypes:

MOM **pp**

DAD **Pp**



- The inheritance of many **<u>human genetic diseases</u>** also follows Mendel's principles and the rules of probability

Genetic disorders are caused by **Dominant** or **Recessive** mutations

SOME AUTOSOMAL DISORDERS IN HUMANS

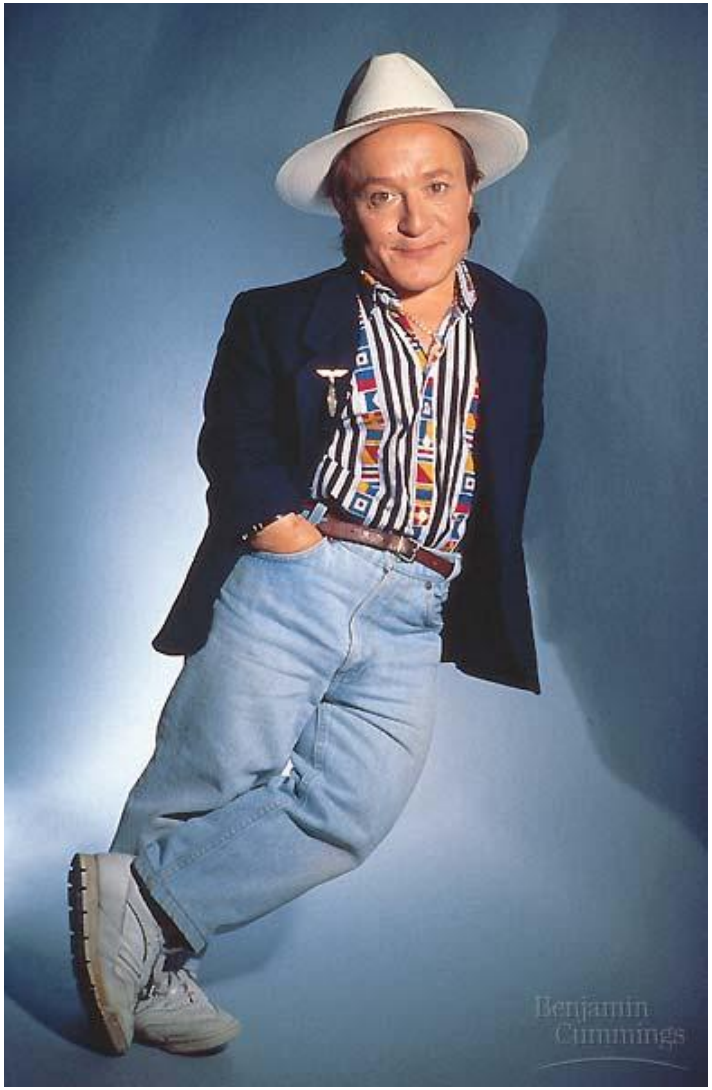
Disorder	Major Symptoms	Incidence	Comments
Recessive disorders			
Albinism	Lack of pigment in skin, hair, and eyes	$\frac{1}{22,000}$	Very easily sunburned
Cystic fibrosis	Excess mucus in lungs, digestive tract, liver; increased susceptibility to infections; death in infancy unless treated	$\frac{1}{1,800}$ Caucasians	See Modules 9.9 and 12.11
Galactosemia	Accumulation of galactose in tissues; mental retardation; eye and liver damage	$\frac{1}{100,000}$	Treated by eliminating galactose from diet
Phenylketonuria (PKU)	Accumulation of phenylalanine in blood; lack of normal skin pigment; mental retardation	$\frac{1}{10,000}$ in U.S.and Europe	See Module 9.10
Sickle-cell disease (homozygous)	Sickled red blood cells; damage to many tissues	$\frac{1}{500}$ African Americans	Alleles are codominant; see Modules 9.13–9.15
Tay-Sachs disease	Lipid accumulation in brain cells; mental deficiency; blindness; death in childhood	$\frac{1}{3,500}$ Jews from central Europe	See Module 4.12
Dominant disorders			
Achondroplasia	Dwarfism	$\frac{1}{25,000}$	See Module 9.9
Alzheimer's disease (one type)	Mental deterioration; usually strikes late in life	Not known	
Huntington's disease	Mental deterioration and uncontrollable movements; strikes in middle age	$\frac{1}{25,000}$	See Modules 9.9 and 12.11
Hypercholesterolemia	Excess cholesterol in blood; heart disease	$\frac{1}{500}$ are heterozygous	Incomplete dominance; see Module 9.12

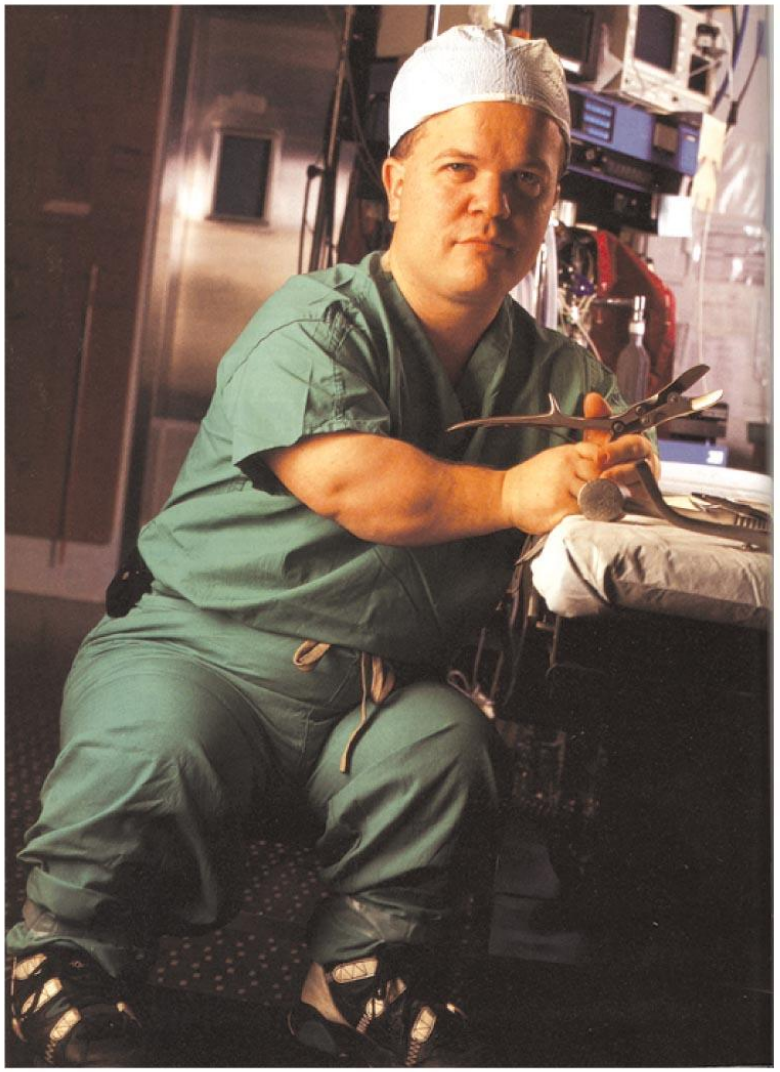
Johnny & Edgar Winter

Albinism…a recessive mutation

albino Africans

- Dwarfism …. A **dominant** mutation





Example 3: XP disorder is caused by a **recessive** mutation. What is the chance that a couple will have a child affected with XP if MOM is a heterozygous carrier and DAD has XP? 1/2

Gene Notation Symbols Used:

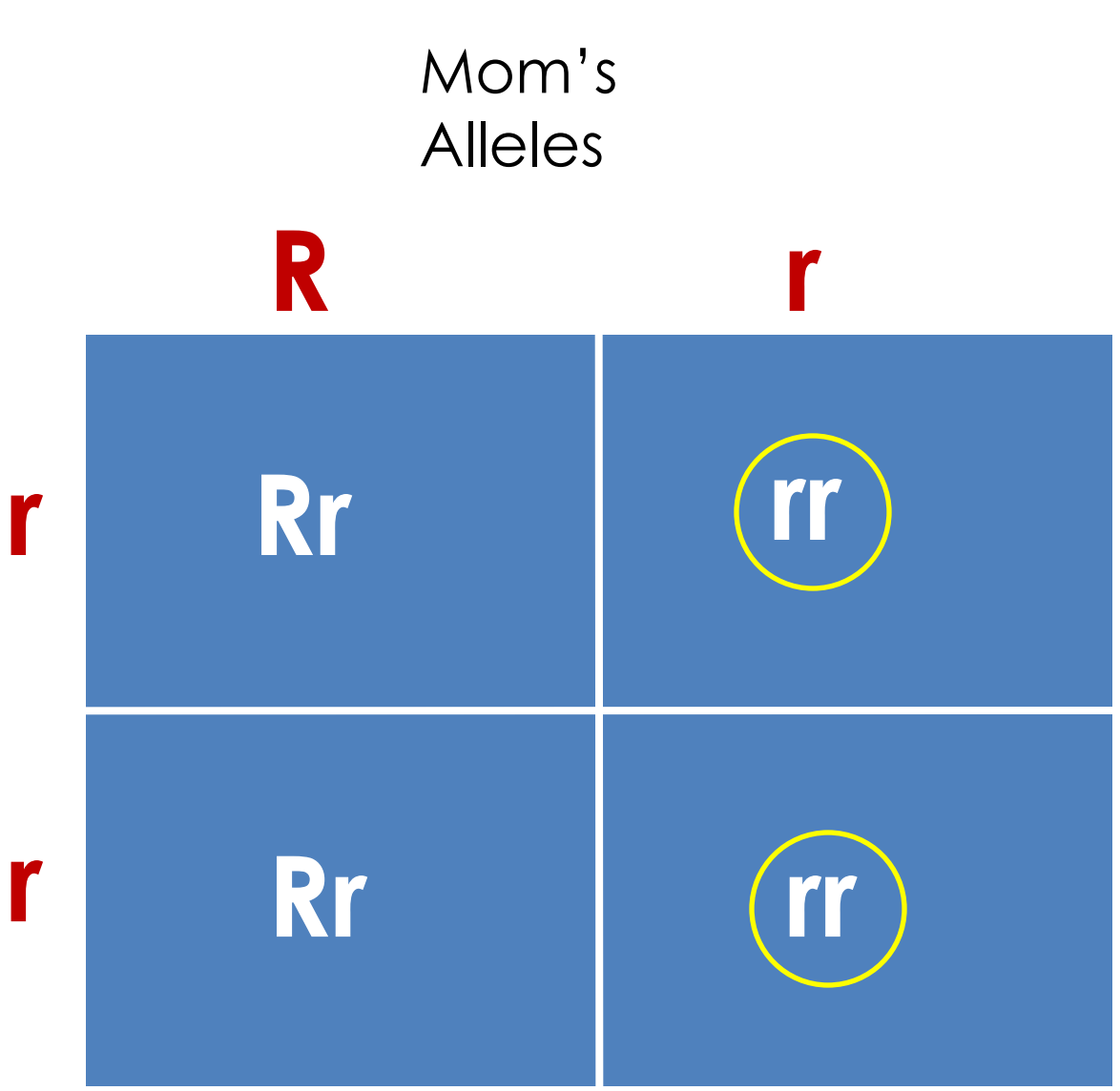
R : Normal RE code

r : Broken code

Parent Genotypes:

MOM: Rr

DAD: rr



Example 4: Huntington's Disease (HD) is caused by a **Dominant** mutation. What is the chance that a couple will have a child affected with HD if MOM is heterozygous for HD and DAD is homozygous normal and disease free? **1/2**

Gene Notation Symbols Used:

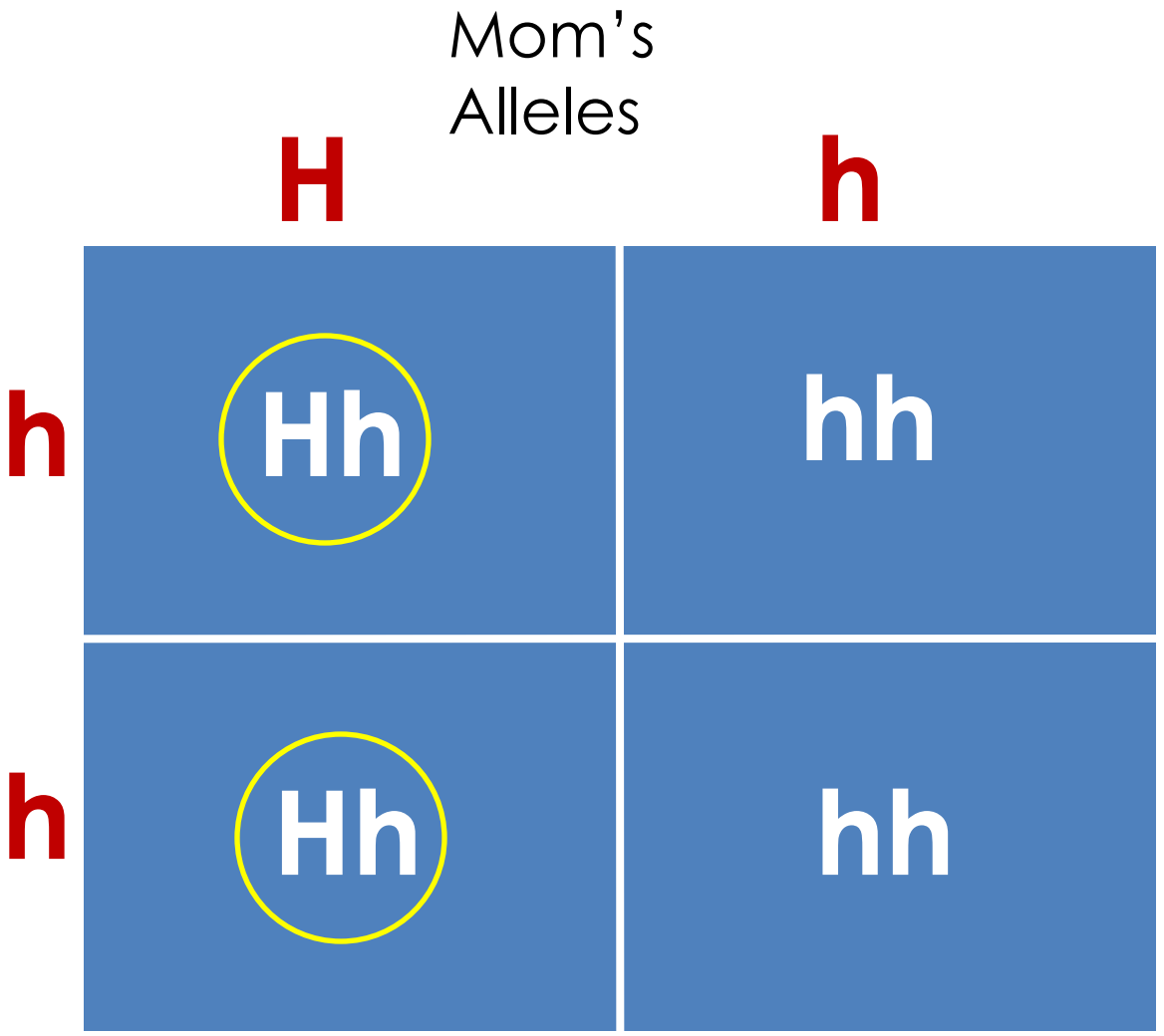
H : **Broken code**

h : **Normal code**

Parent Genotypes:

MOM: **Hh**

DAD: **hh**



Example 5: Dwarfism(HD) is caused by a **Dominant** mutation. What is the chance that a couple who are both dwarfs will have a child with NORMAL height if MOM and DAD are heterozygous for dwarfism? **1/4**

Gene Notation Symbols Used:

D : **Broken code**

d : **Normal code**

Parent Genotypes:

MOM: **Dd**

DAD: **Dd**

Mom's Alleles

Dad's Alleles

	D	**d**
D	DD	Dd
d	Dd	dd

Let's Review

- Genetic diseases usually happen in 1 of 2 ways:

1) A person inherits 1 or more ___mutated___ DNA codes => ___broken___ proteins inside cells that don't work correctly

Examples?

Remember:

A) If the mutation is Dominant => any person who inherits at least ___1___ mutation will show the disease

B) If the mutation is Recessive => only people who inherit ___2___ mutations will show the disease

C) If the mutation is Recessive => people who inherit only ___1___ mutation will be healthy ___carriers___ who could pass the mutation to their kids

2) A person inherits the wrong ___#___ of chromosomes => ___confusion___ during development

Examples?

- Notice anything wrong with this karyotype?

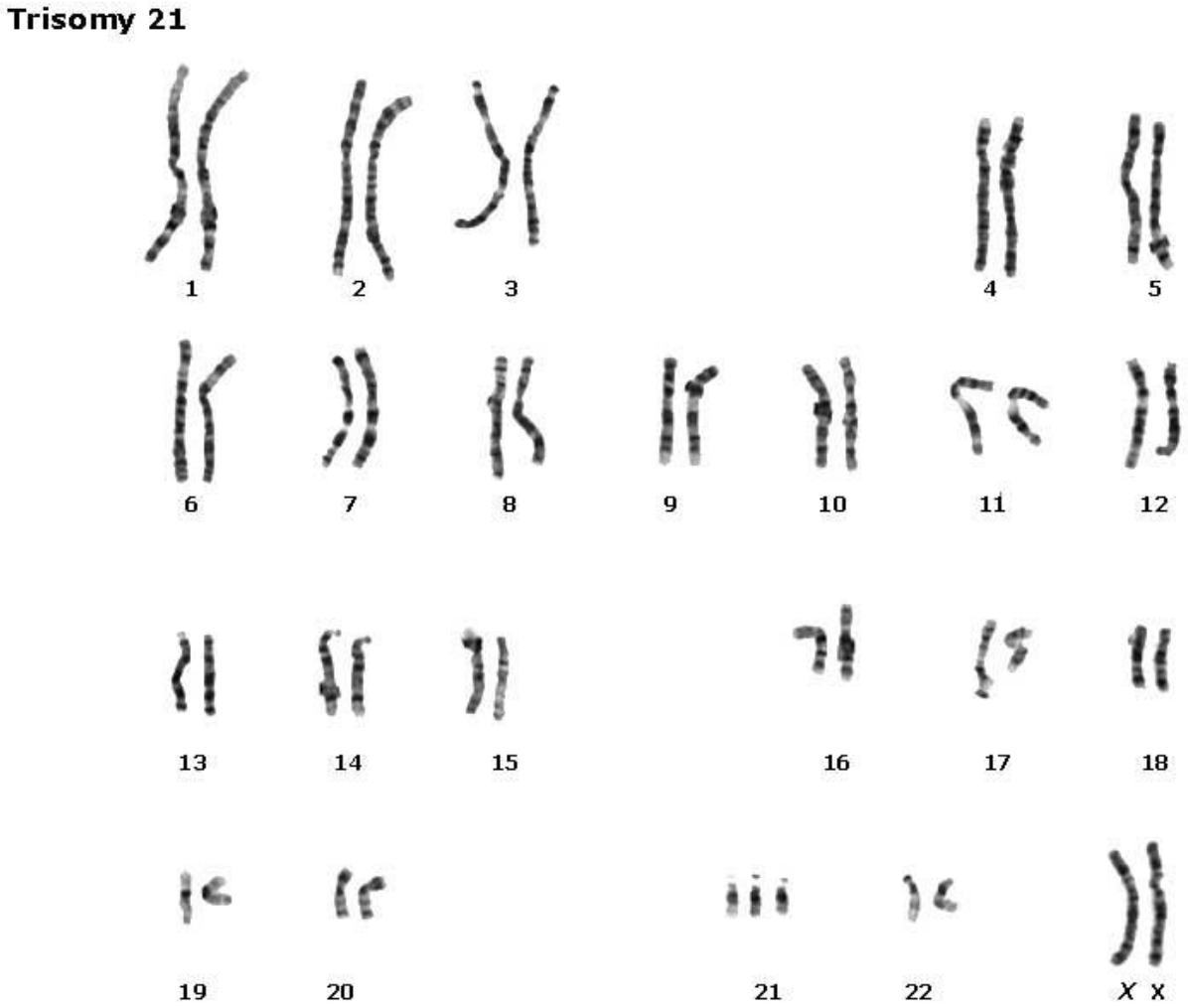


Figure 8.20Ax

An extra copy of chromosome 21 causes Down Syndrome

- This karyotype shows three number 21 chromosomes

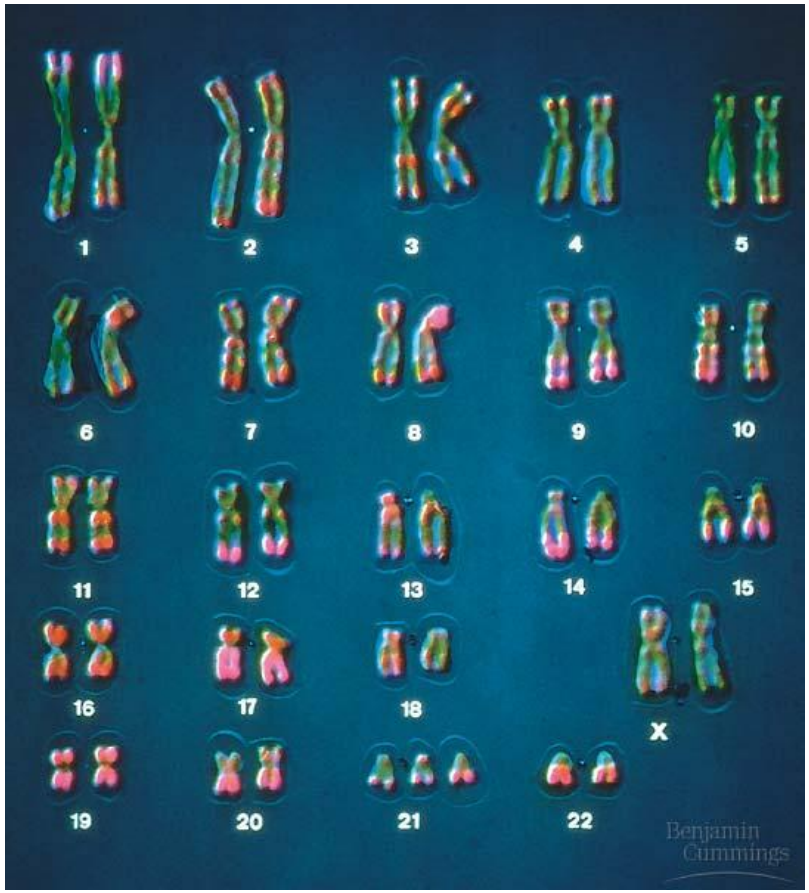


Figure 8.20A, B

- The chance of having a Down syndrome child goes up with MOM's age …WHY?

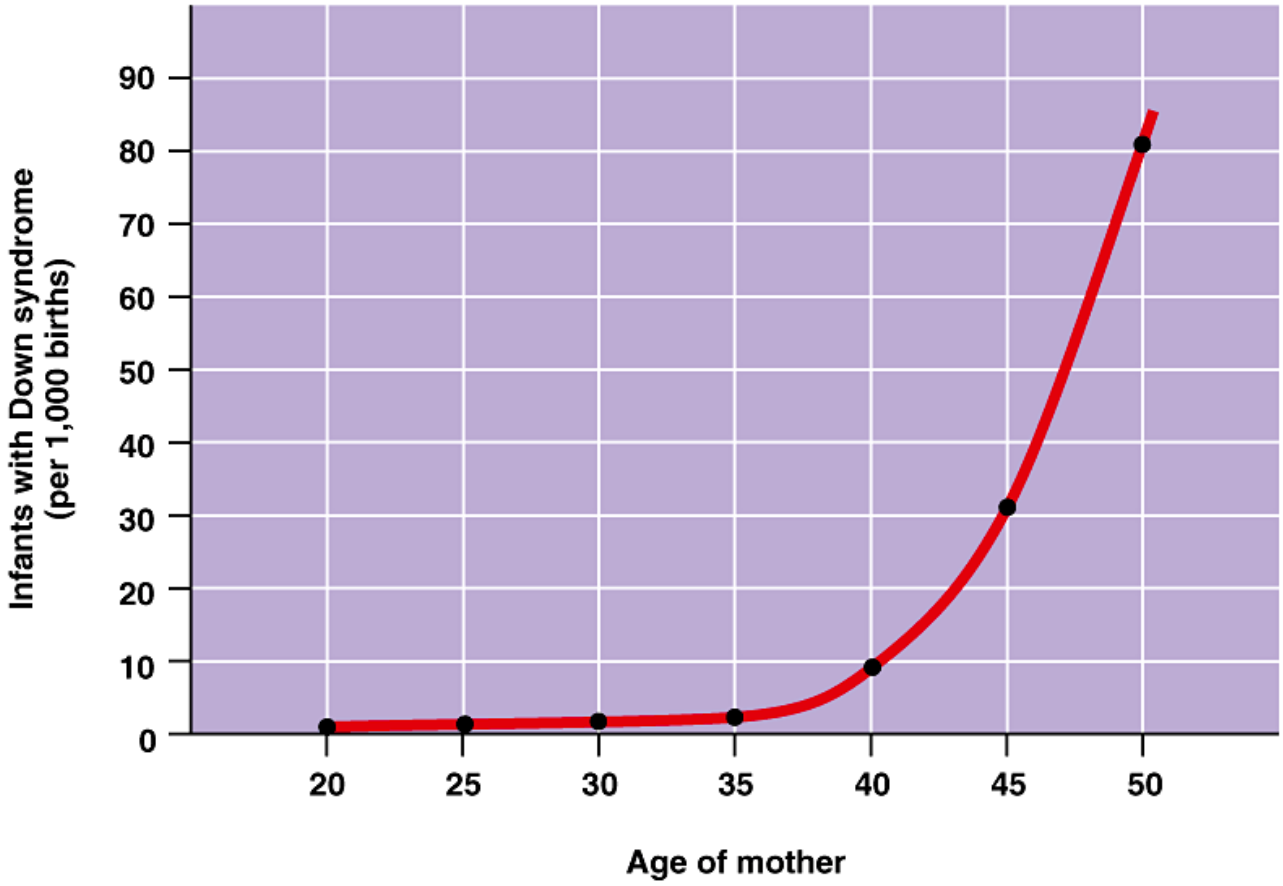


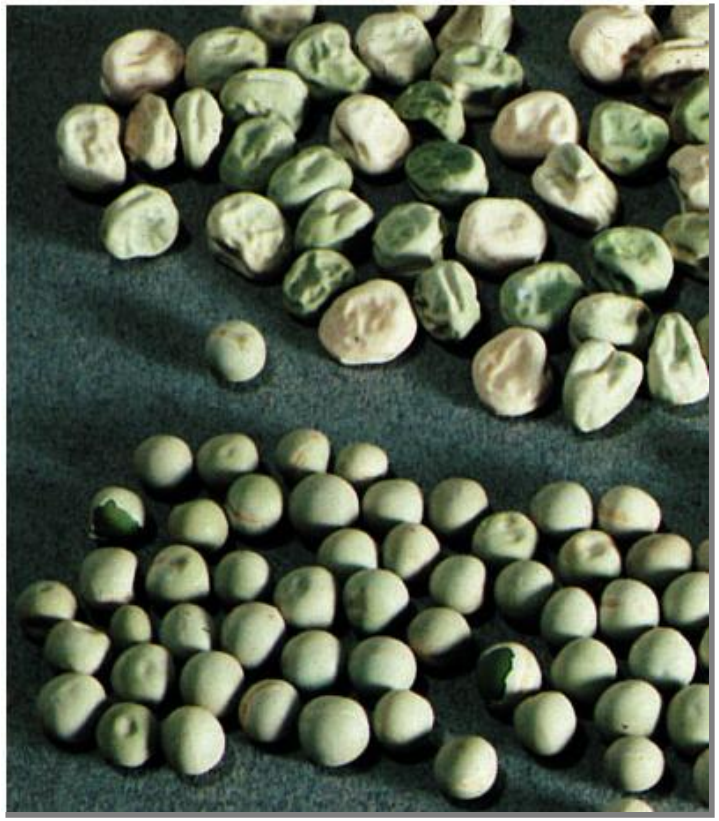
Figure 8.20C

Topic 4: TWO-Trait Crosses

Mendel continued his studies with pea plants by following the inheritance of 2 different traits at the same time

Dihybrid cross

- Mendel's experiments continued by following the inheritance of 2 different characters
  - seed color and seed shape
  - dihybrid crosses



Introducing the law of independent assortment that applies when tracking two characters at once

- **Law of independent assortment**
  - Each pair of alleles segregates independently of the other pairs of alleles during gamete formation
  - What are the 4 possible gamete types that are created in equal amounts during Meiosis for the genotype ***RrYy*** *?*

    Hint: time to FOIL

1) RY 2) rY 3) Ry 4) ry

The **Law of Independent Assortment** is revealed by tracking <u>two</u> characteristics at once (AKA <u>Dihybrid Cross</u>)

Mom's genotype: BbRr (Black fur & running mouse)

possible egg varieties: BR Br bR br

Dad's genotype: BbRr (Black fur & running mouse)

possible sperm varieties: BR Br bR br

	BR	Br	bR	br
BR	BBRR	BBRr	BbRR	BbRr
Br	BBRr	BBrr	BbRr	Bbrr
bR	BbRR	BbRr	bbRR	bbRr
br	BbRr	Bbrr	bbRr	bbrr

Phenotype Probabilities:

- Black fur, Running: 9 /16
- Black fur, waltzing: 3 /16
- Brown fur, Running: 3 /16
- Brown fur, waltzing: 1 /16

B = black fur in mice b = brown fur R= running mice r= waltzing mice

- When Mendel studied controlled crosses for **2 traits** over 2 generations he discovered consistent F_2 phenotype fractions:

– Show both dominant traits **9** /16

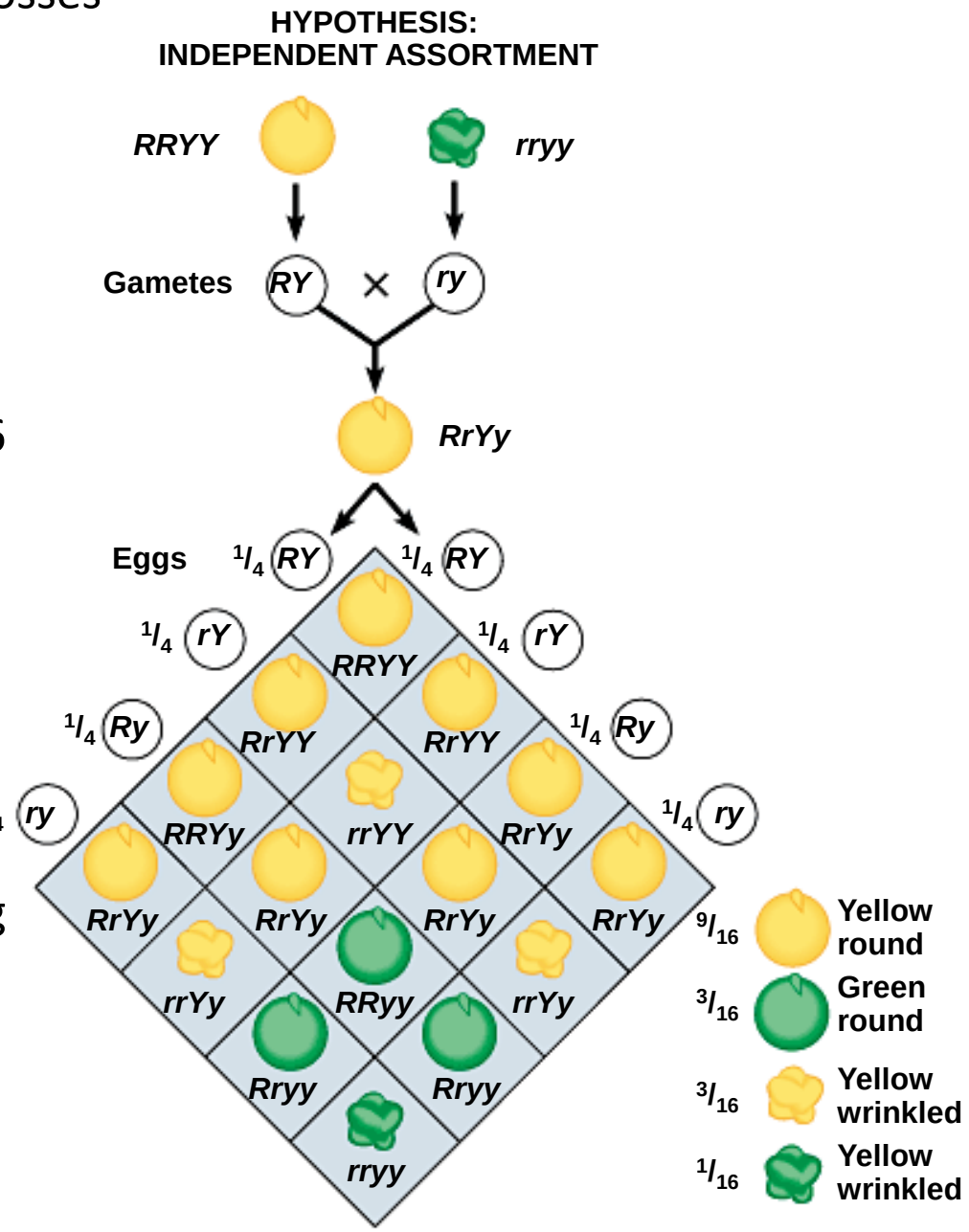
– Show 1 dominant & 1 recessive **3** /16

– Show other dominant & recessive **3**/16

– Show both recessive traits **1** /16

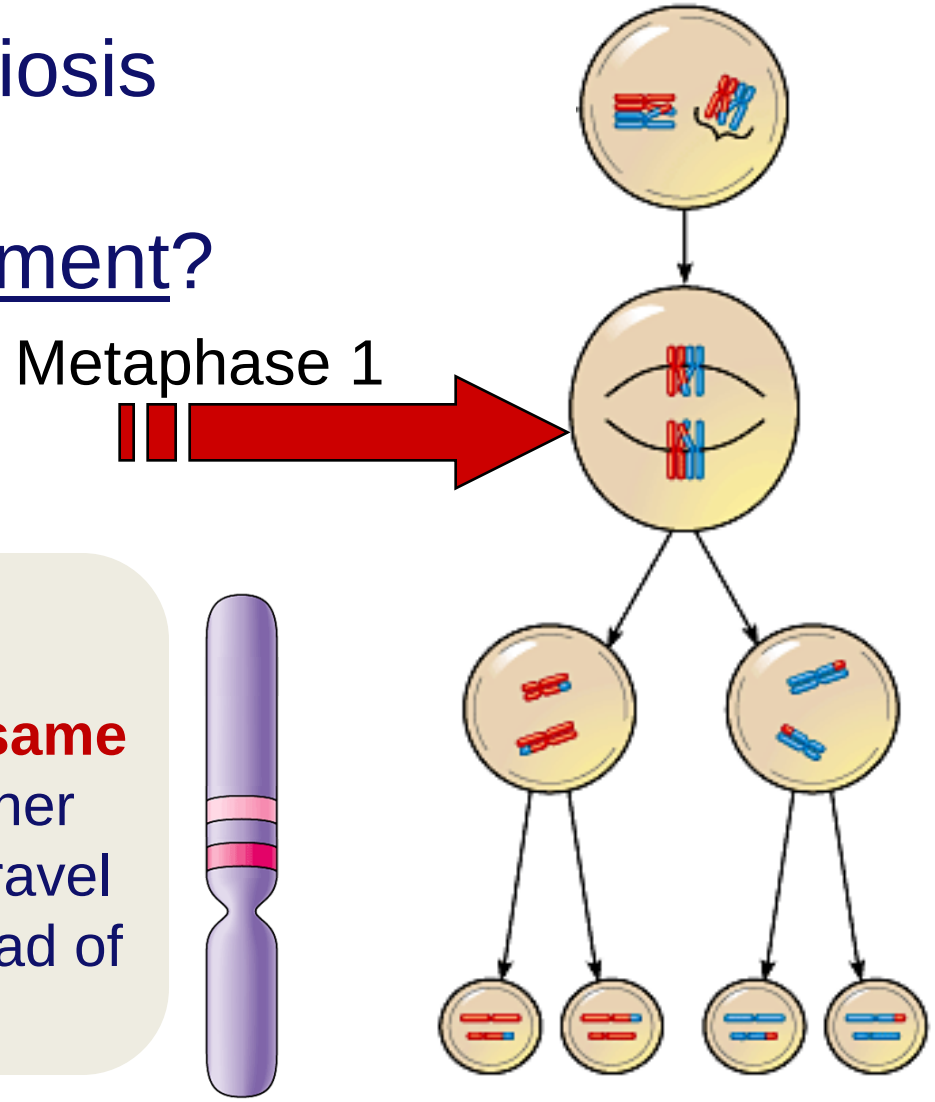
- WHY? …. Mendel again concluded that the rules of math probability will explain these F2 phenotype fractions only if the alleles for 1 trait segregate independently of the other trait's allele pairs during Meiosis gamete formation

– This is known as the **Law of Independent Assortment**



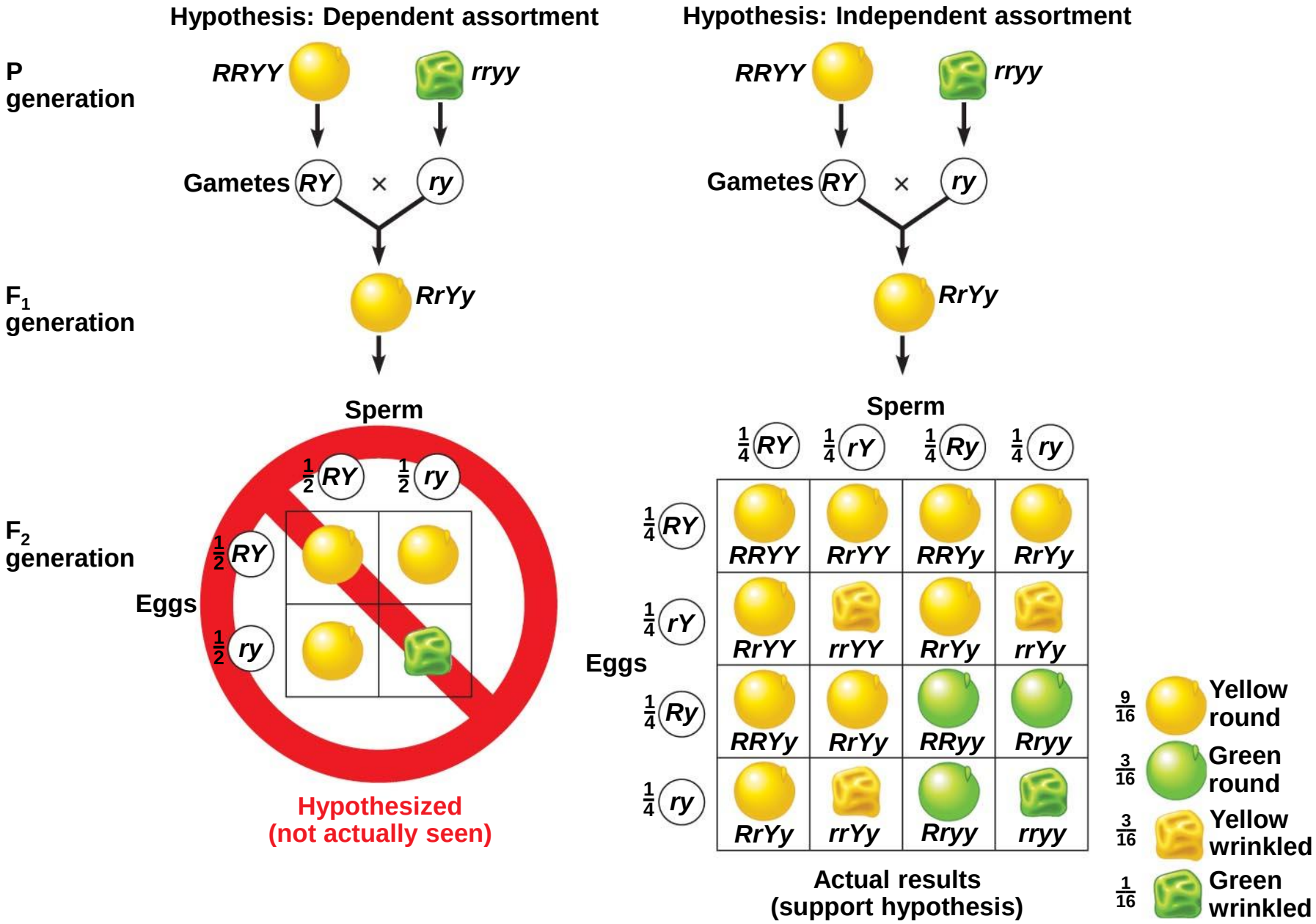
Law of Independent Assortment

- Which stage of meiosis creates the law of <u>independent assortment</u>?

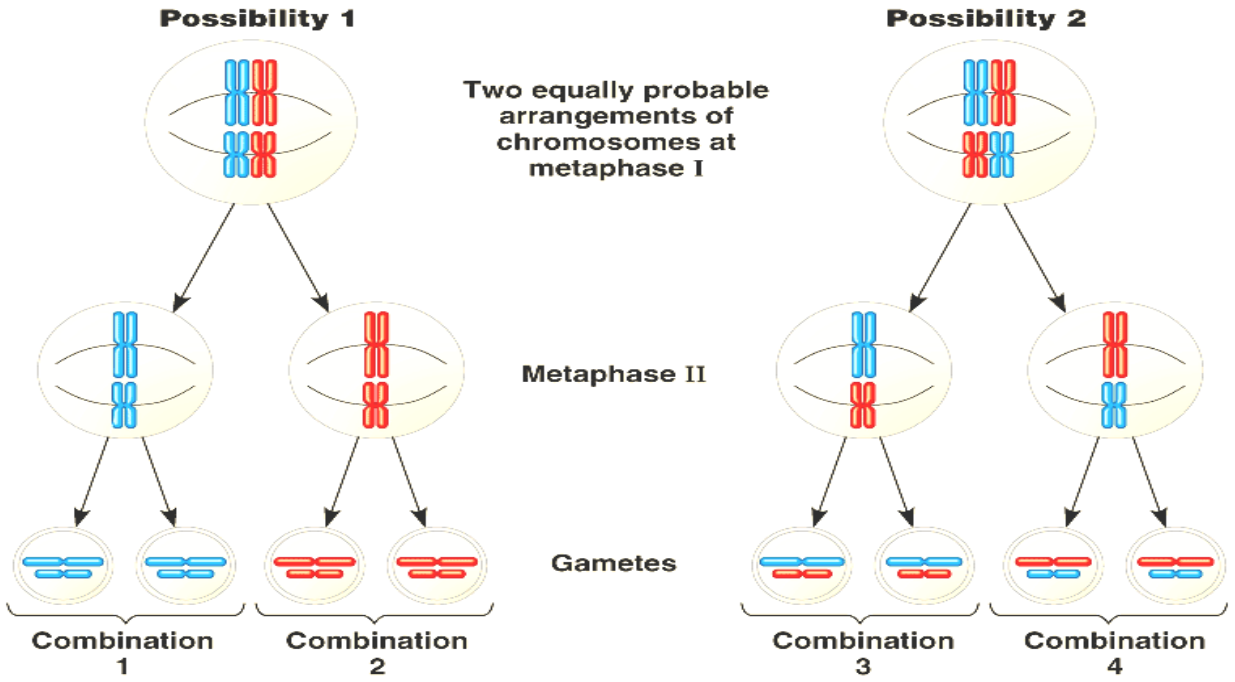


EXCEPTION

- Won't work if genes are on **same chromosome** & close together
- This means the two genes travel together during meiosis instead of going separate ways

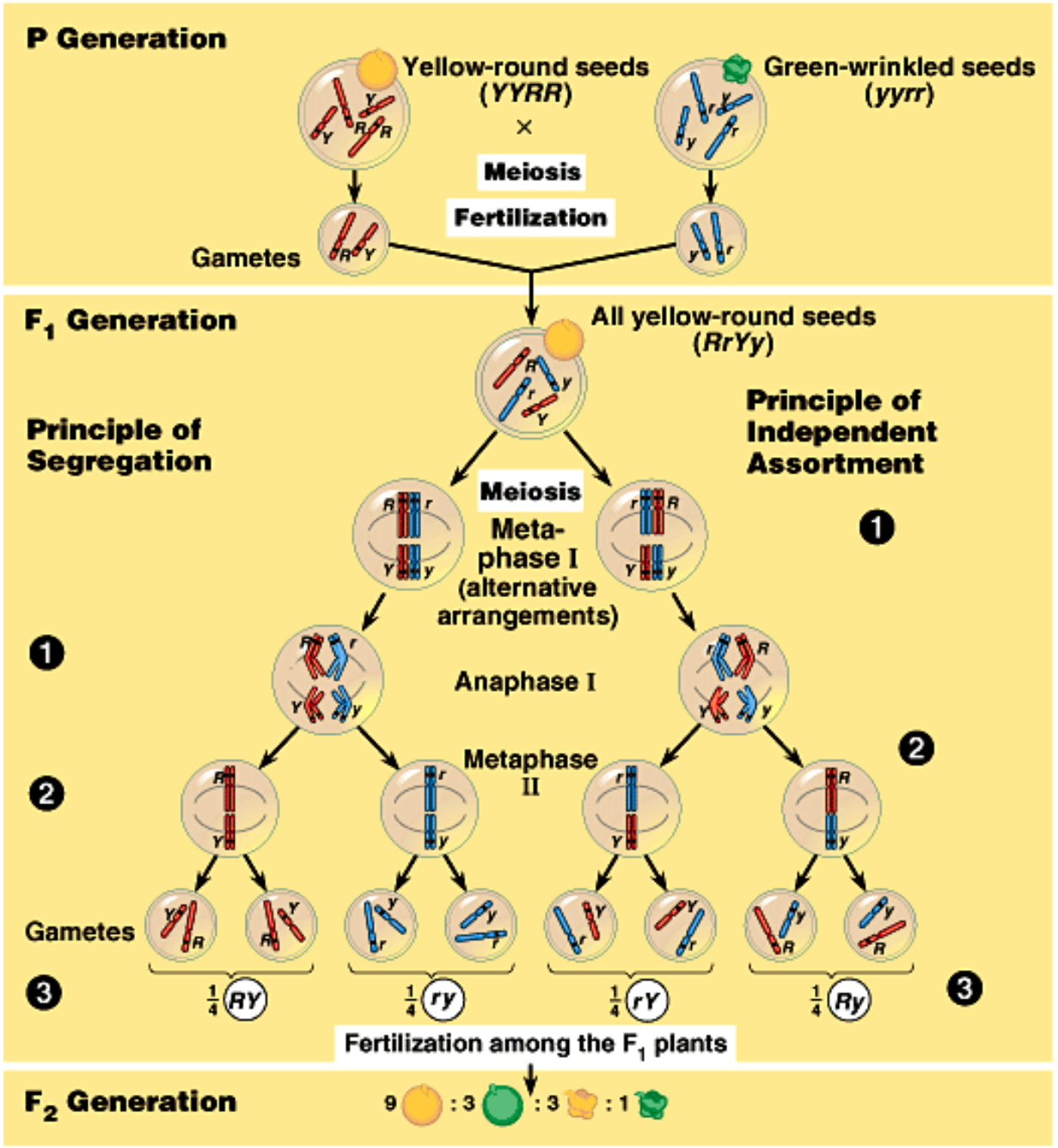


Basically, for any 2 traits that you might pay attention to as you go through Meiosis to make a gamete, the 2 chromosomes carrying those alleles can line up in different random ways during Metaphase I, and that means that the gamete produced might have both alleles from your DAD, both alleles from your MOM, or 1 allele from MOM and 1 allele from DAD.

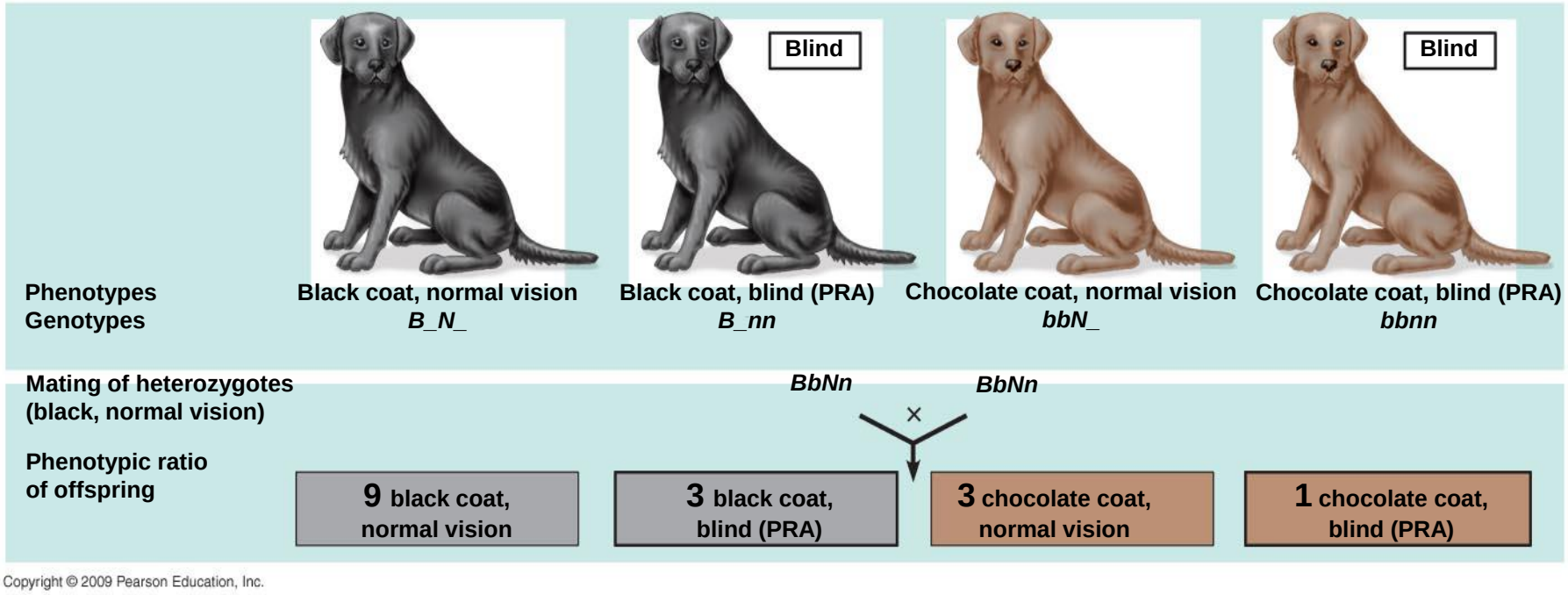


The chromosomal basis of Mendel's laws…

Trace the genetic events through meiosis, gamete formation & fertilization to offspring



Mendel's Dihybrid results with pea plants also apply to animals like dogs

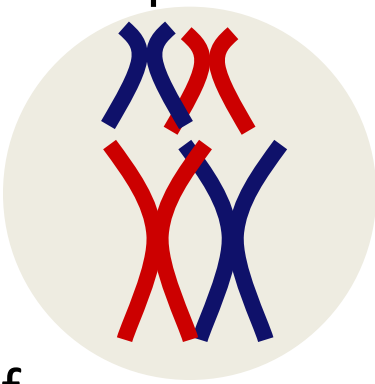


Review: Mendel's laws of heredity

- **Law of segregation**
  - Applies to inheritance of single traits
  - Answers the question: Why don't 2 alleles ever end up in the same gamete?
  - each allele **segregates** (goes a different direction during **Anaphase 1**) into separate gametes

- **Law of independent assortment**
  - Applies to inheritance of 2 traits
  - genes on **separate chromosomes** assort into gametes independently
  - Happens because of the random arrangement of chromosome pairs during **Metaphase 1** (Mom..Mom..Dad..Mom…etc, lineup is different each time)
  - **EXCEPTION**: won't work if the 2 traits are located as neighbors on the **same chromosome** = linked genes

metaphase1



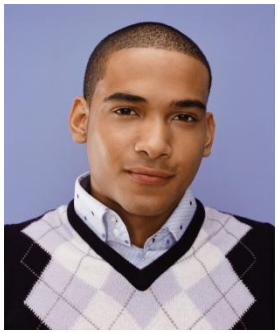
Topic 5: Deeper Mysteries of Heredity

AKA … Beyond what Mendel could explain

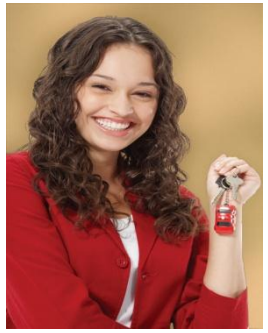
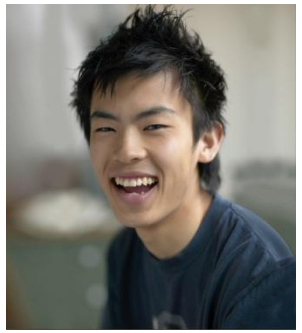
6.3 Mendel and Heredity

KEY CONCEPT

Phenotype is affected by many different factors.






Some traits are determined by more than the simple interaction of dominant and recessive alleles

- **Incomplete Dominance** happens when a trait is a _____blend_____ of the two alleles
- Example 1: Crossing green and steel blue betta fish creates a blended_____Royal blue_____ fish

Green

+

Steel Blue

=

Royal blue

Some traits are determined by more than the simple interaction of dominant and recessive alleles

- Another example of **Incomplete Dominance** happens with some flowers
- Example 2: Crossing red and white flowers creates a blended_____ flower

Pink

Red

+

white

=

Pink

- Hypercholesterolemia is an example of **Incomplete dominance** in humans

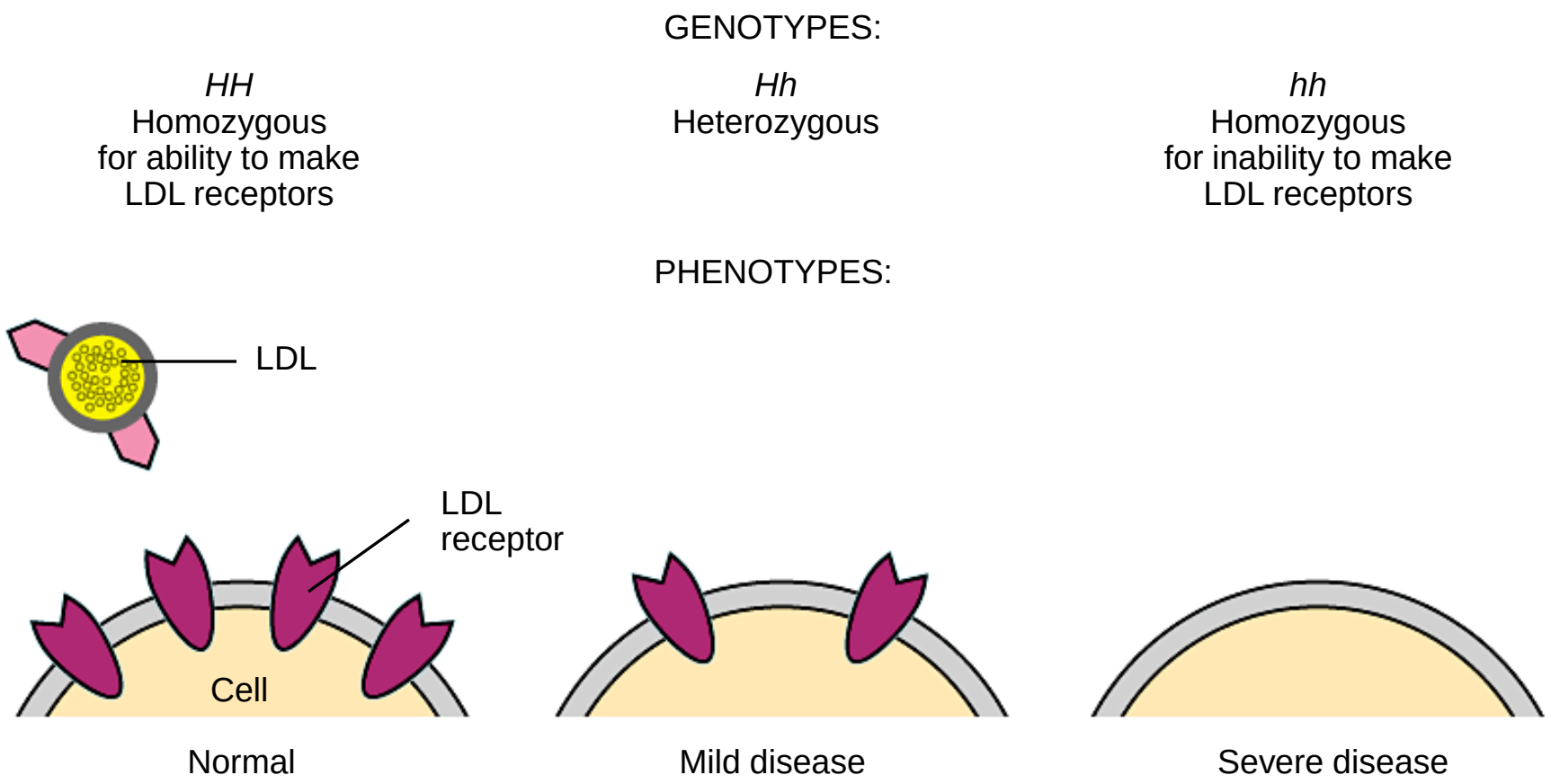


Figure 9.12B

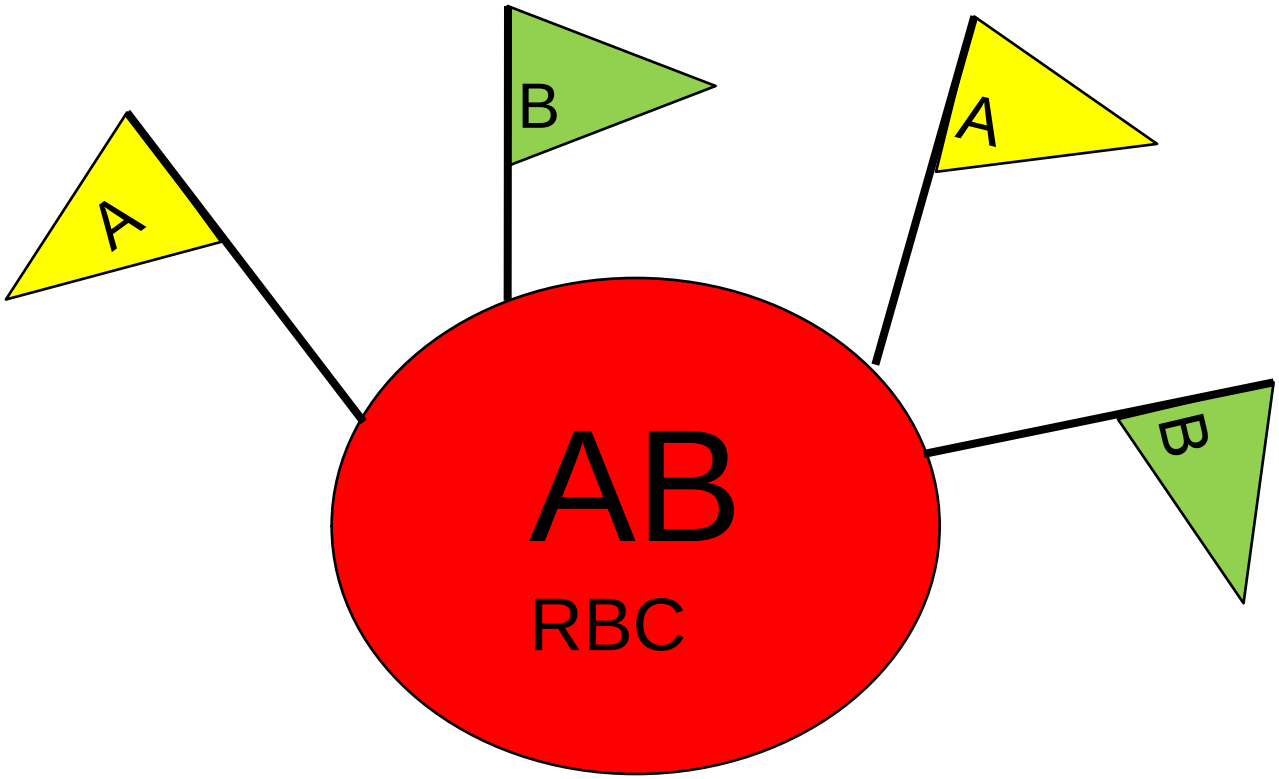
Some traits are determined by more than the simple interaction of dominant and recessive alleles

- **Codominance** is another more complex situation that happens when two alleles are _both_ expressed together at the same time

- Example 1: Some people inherit an _A_ blood allele from one parent and a _B_ blood allele from the other parent and end up expressing both codes with _AB_ blood

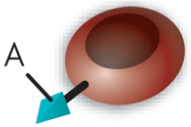
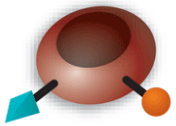
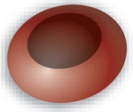
A allele + B allele = AB blood

- Sometimes the 2 alleles for a trait both show at the same time = **<u>Codominance</u>**
- Examples: Type AB blood in humans



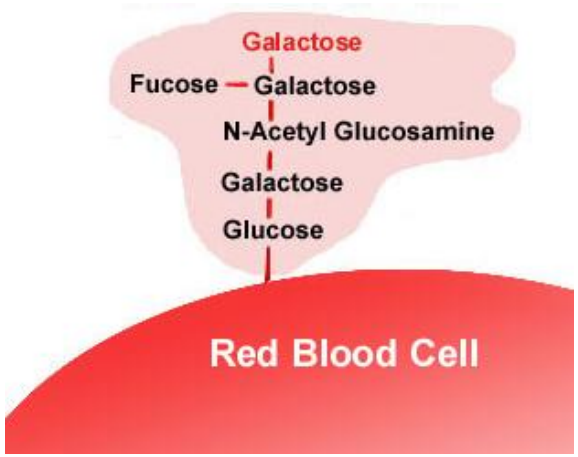
6.3 Mendel and Heredity

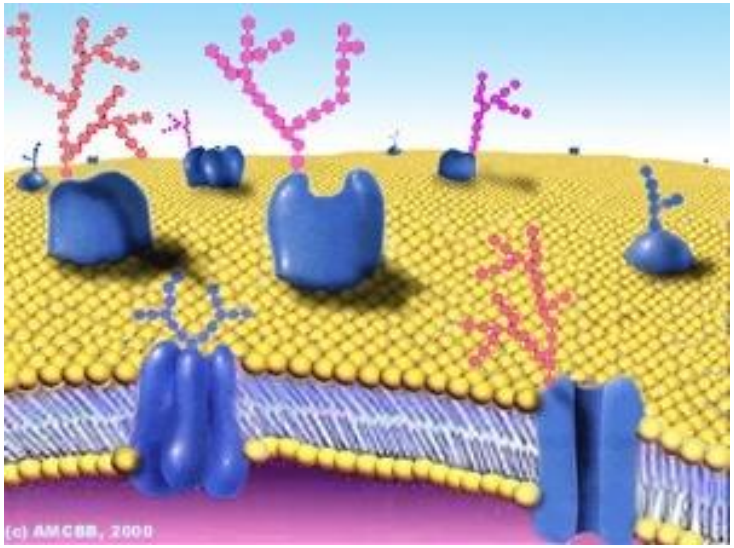
- Codominant alleles will both be completely expressed.

PHENOTYPE (BLOOD TYPE)		GENOTYPES
A	antigen A 	I^AI^A or I^Ai
B		I^BI^B or I^Bi
AB	both antigens 	I^AI^B
O	no antigens 	ii

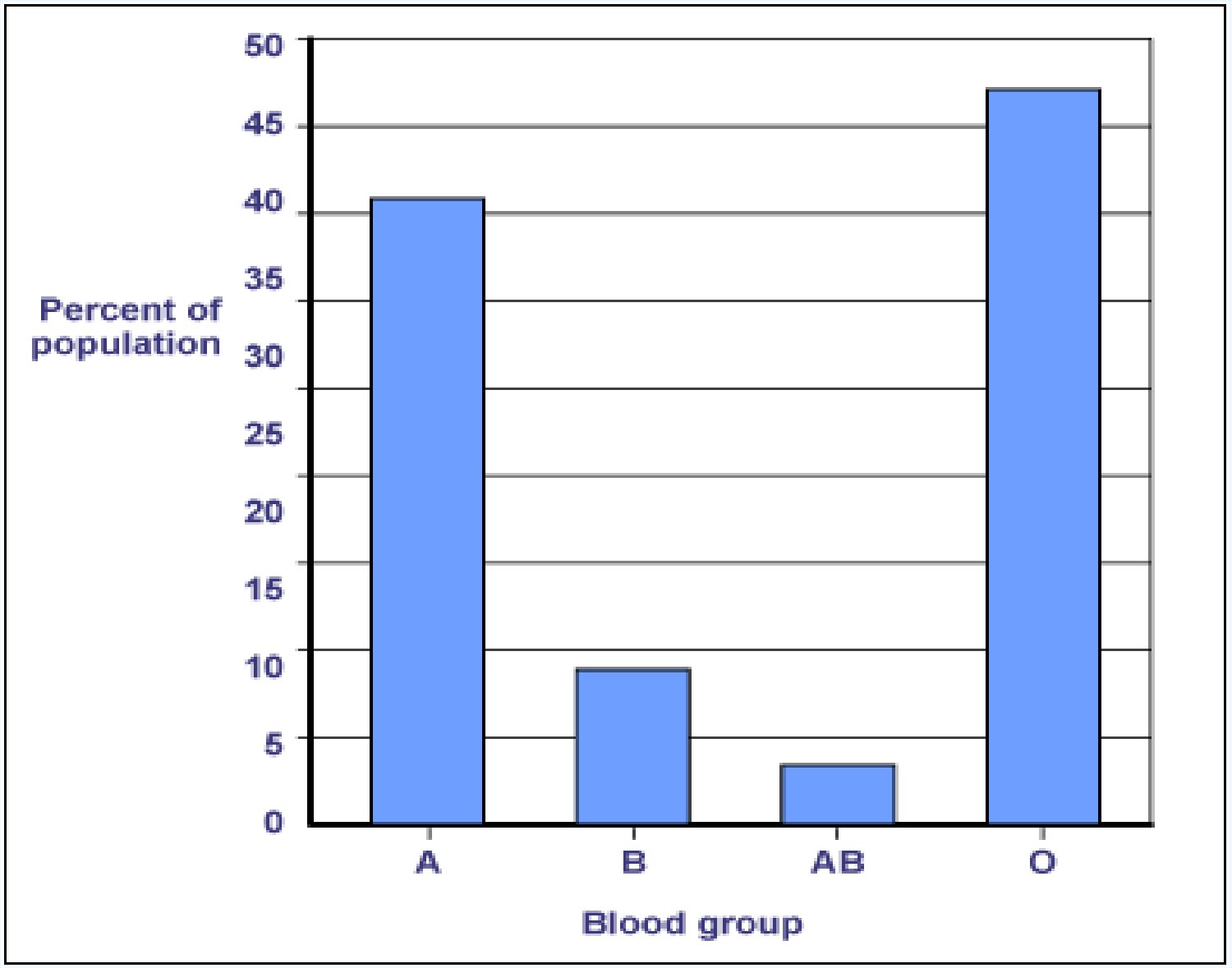
Many genes have more than two alleles in the population = **Multiple Alleles**

- Human ABO blood types are determined by **3** alleles in the human gene pool:
- The alleles for A and B blood types are codominant, and have the following symbols: I^A I^B
- The O allele is recessive = i

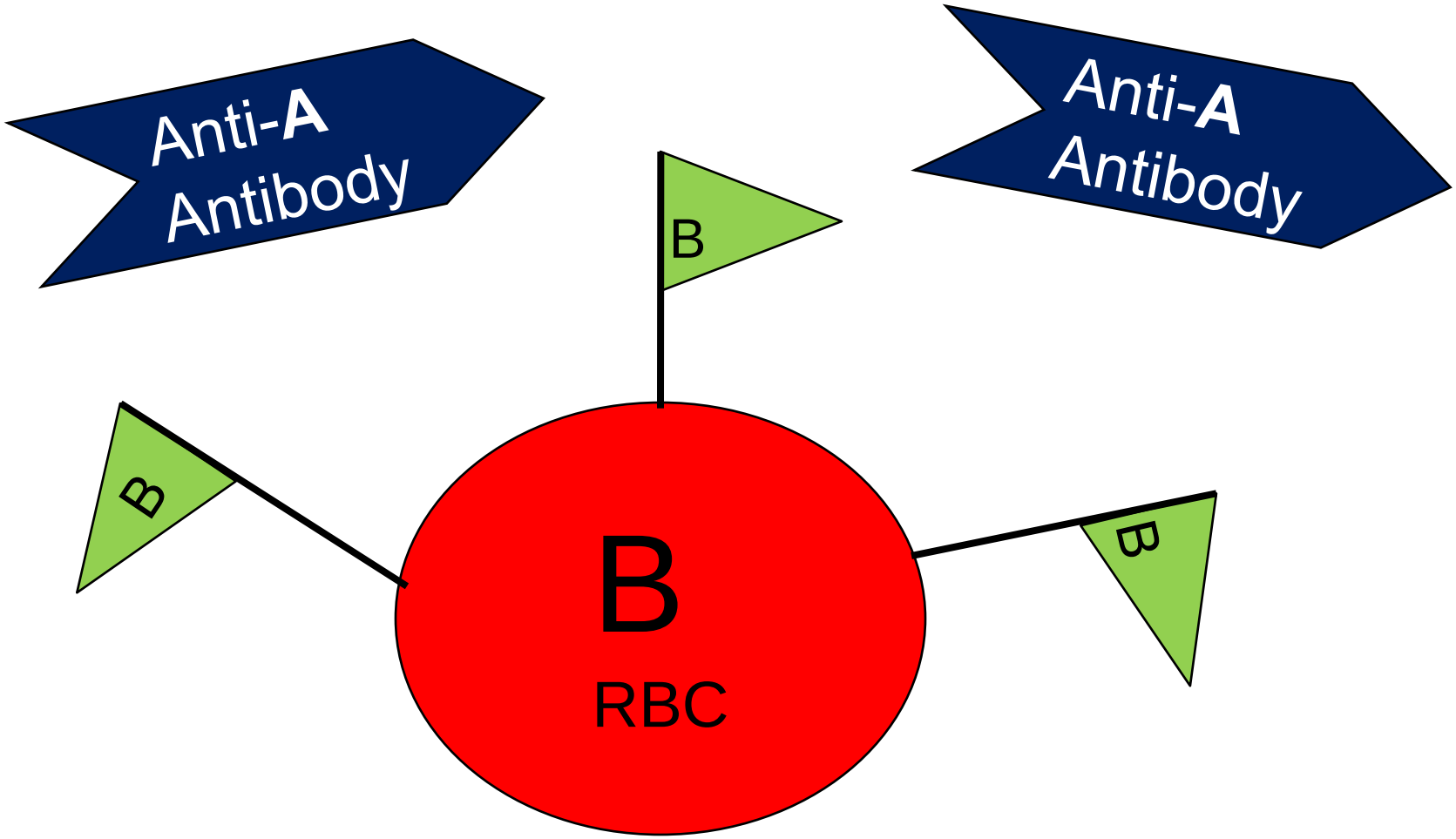




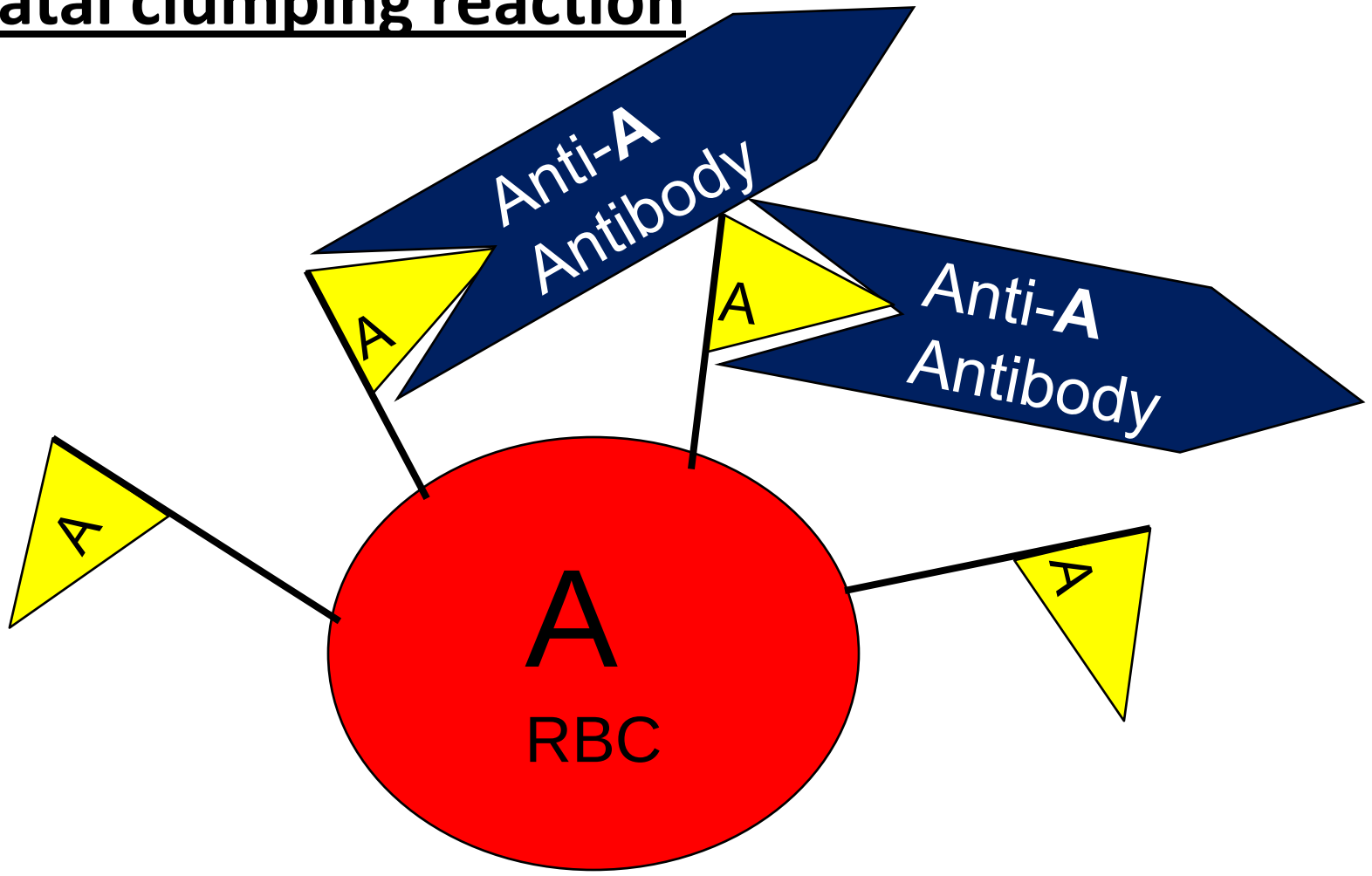
Blood Type Frequencies



- People with B blood are born with antibodies against A type blood



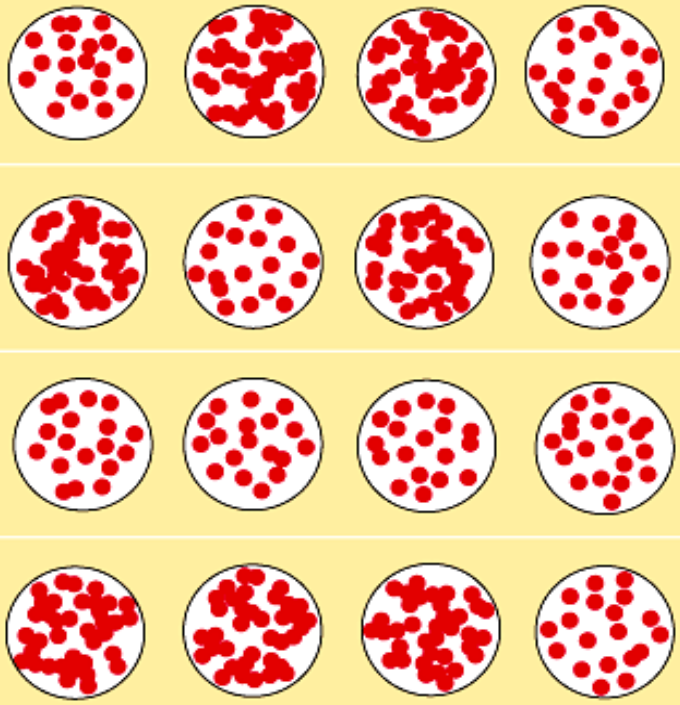
- If B blood people receive A blood during a transfusion, the anti-A antibodies will cause a **<u>fatal clumping reaction</u>**



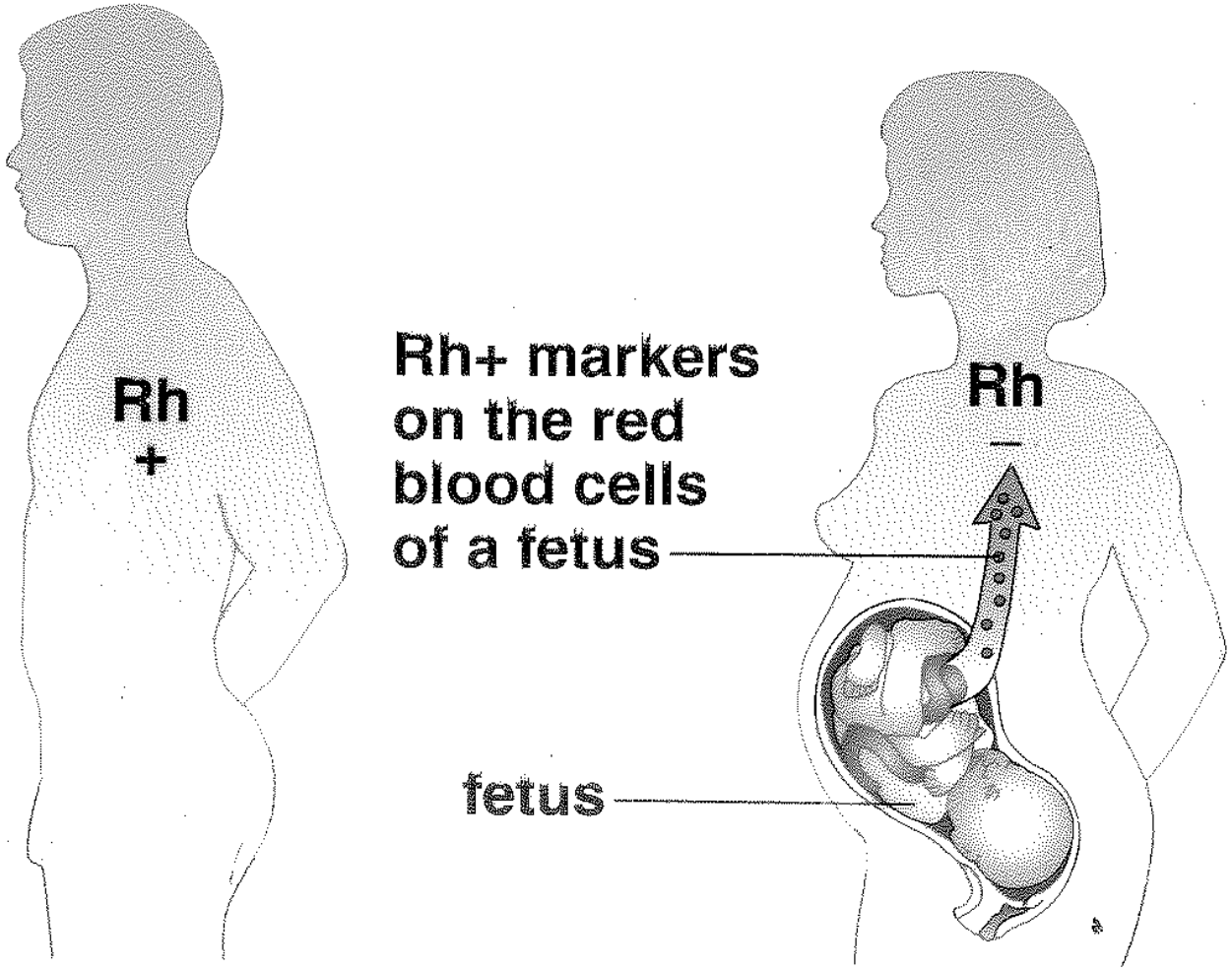
Blood donation

What types of blood can a person with **O** blood NOT receive ???

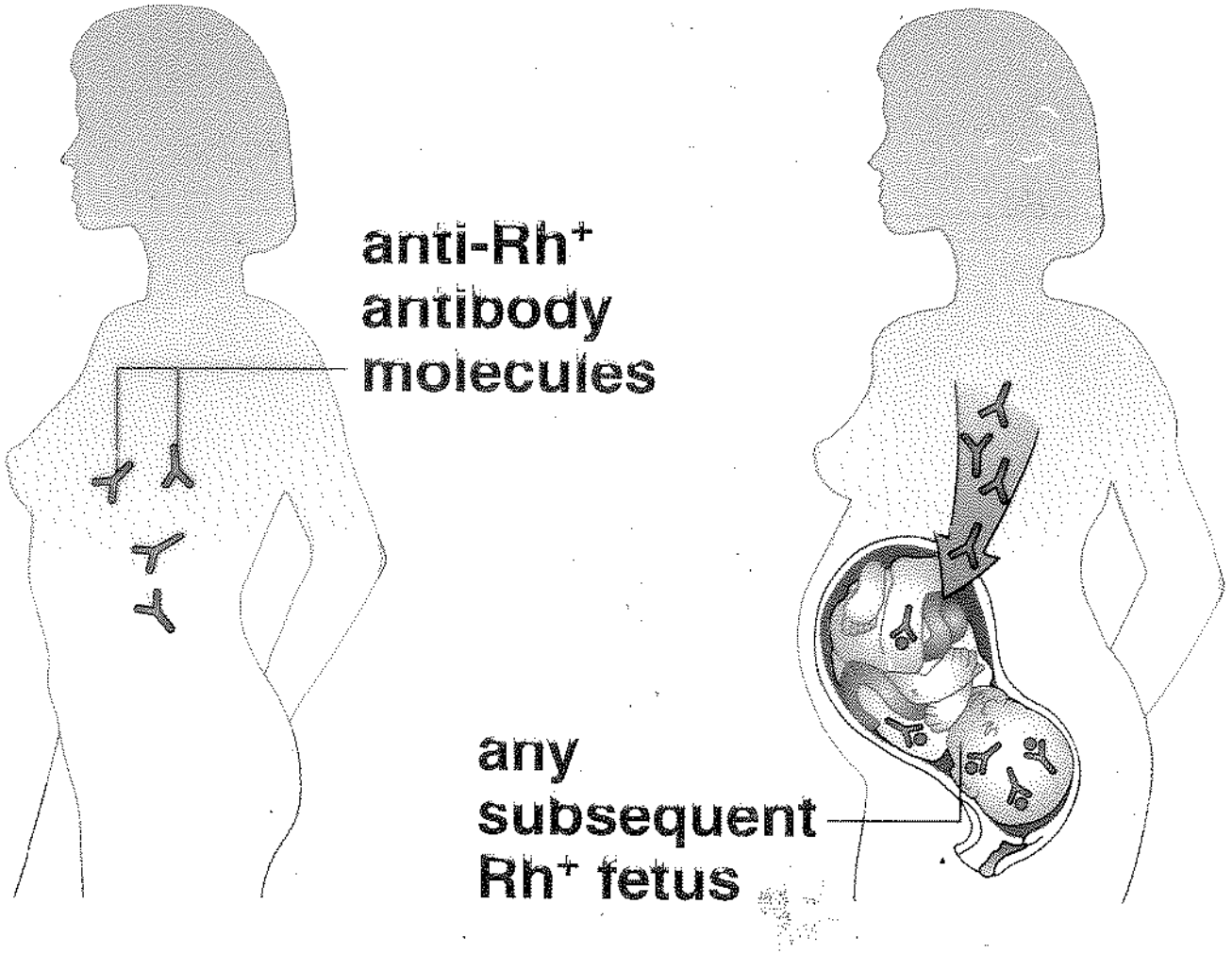
(a) Phenotype (blood group)	(b) Genotypes (see p.258)	(c) Antibodies present in blood serum	(d) Results from adding red blood cells from groups below to serum from groups at left			
			A	B	AB	O
A	$I^A I^A$ *or* $I^A i$	Anti-B				
B	$I^B I^B$ *or* $I^B i$	Anti-A				
AB	$I^A I^B$	—				
O	*ii*	Anti-A Anti-B				



So what is the RH factor ??? = (+ or -)



Rh troubles happen for the 2nd baby if MOM is **RH -**

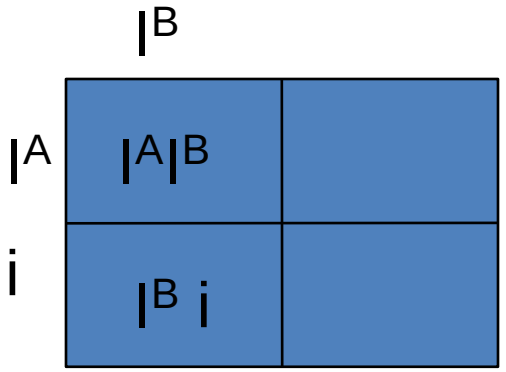


Blood Type Punnett Square:

- List all the possible blood genotypes and phenotypes and their corresponding fractions for children conceived from a male heterozygous for type A blood with a woman with homozygous type B blood.

MOM = $I^B\ I^B$

DAD = $I^A\ i$



Genotypes	fractions	Phenotypes	fractions
$I^A I^B$	1/2	Type AB blood	1/2
I^B i	1/2	Type B blood	1/2

Some traits are determined by more than the simple interaction of dominant and recessive alleles

- Another example of **Codominance** happens with some horses and cows
- Example 2: Crossing black and white horses creates a Roan horse

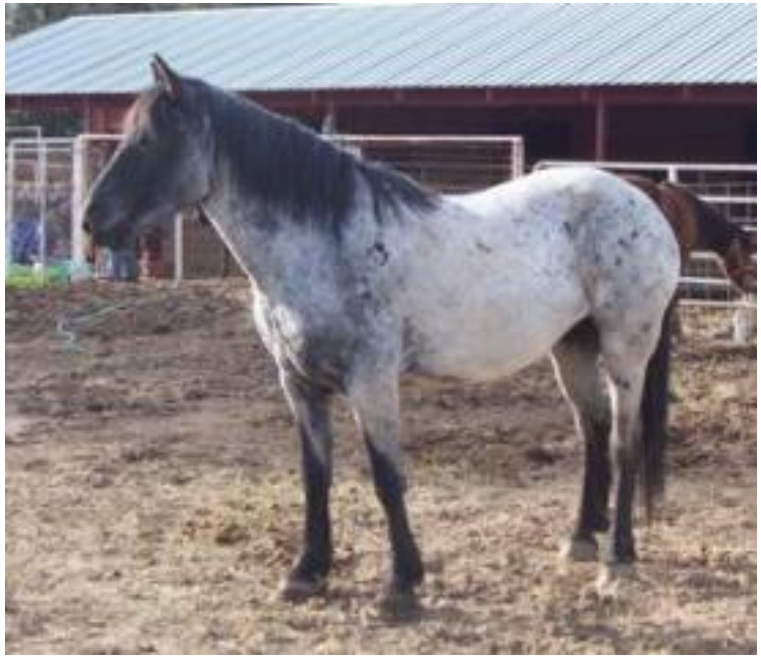
Black

+

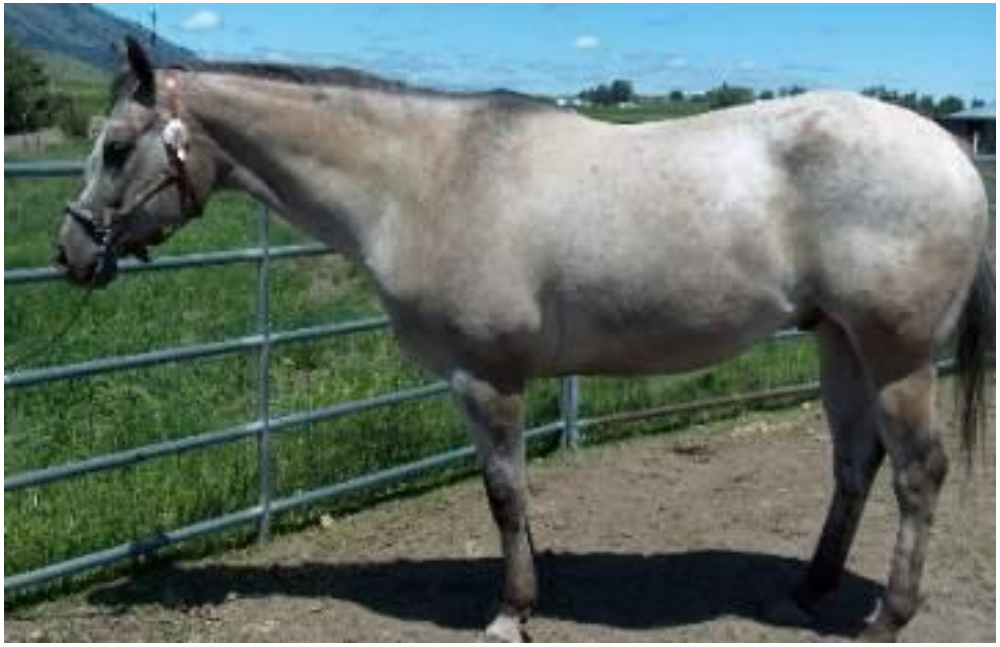
white

=

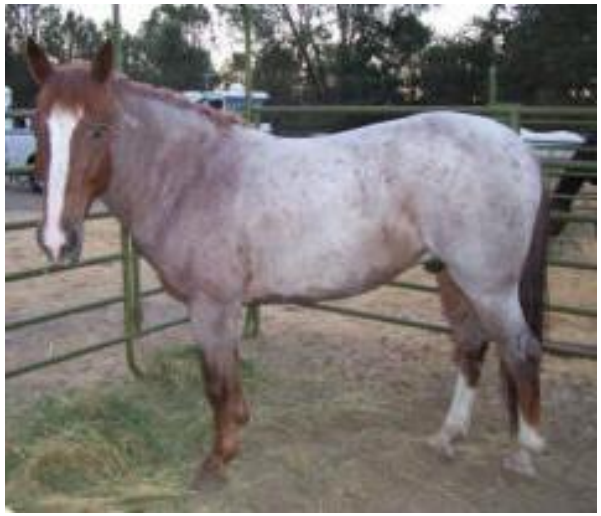
Roan



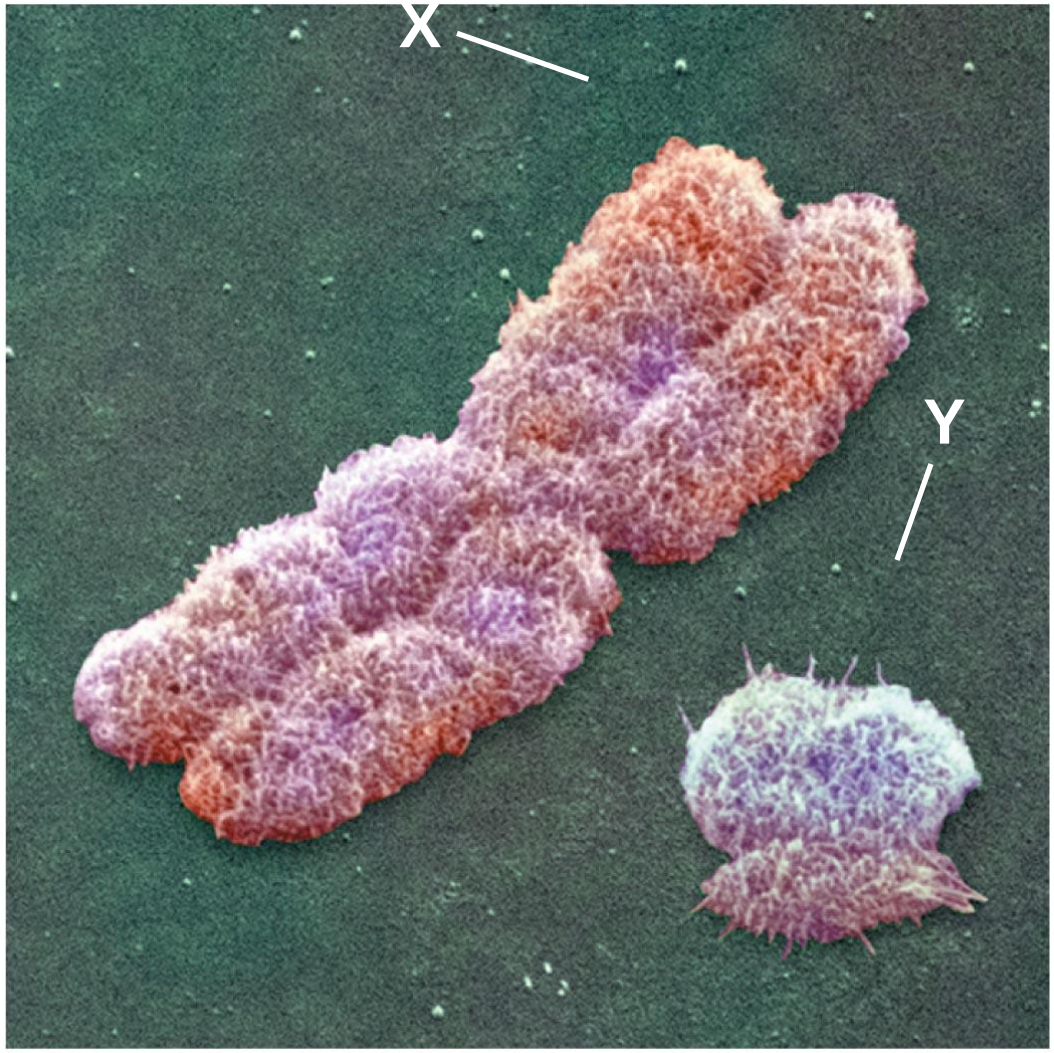
Roan



ROAN horses and cows are another example of **Codominance** … 2 colors are each expressed at the same time in a “salt-n-pepper” effect

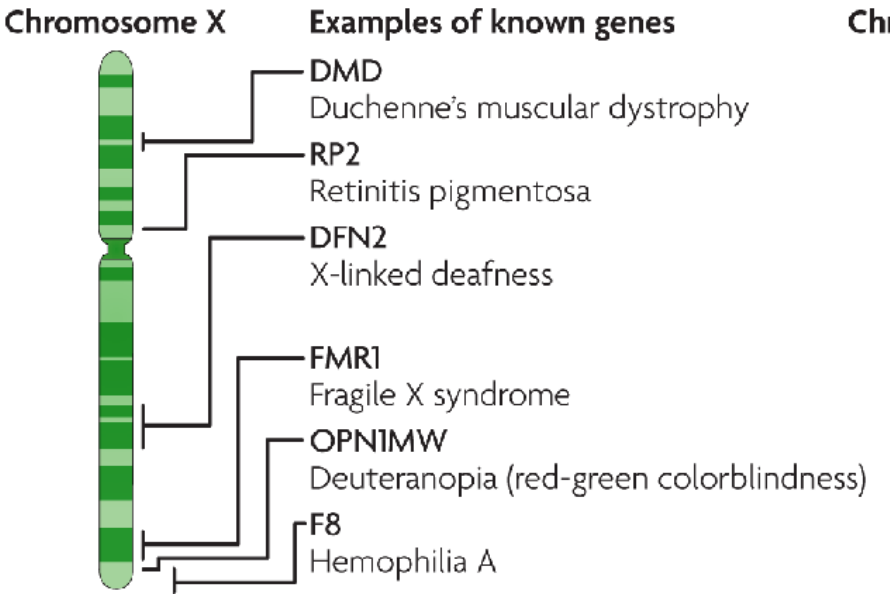


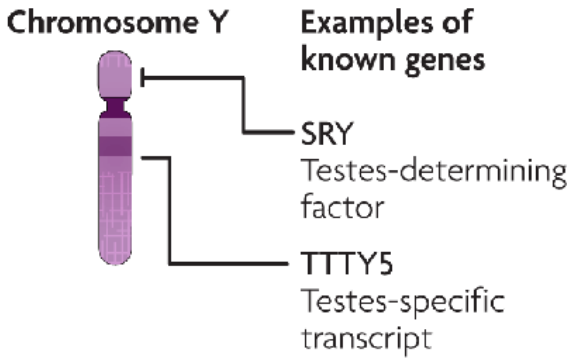
Boy or Girl?

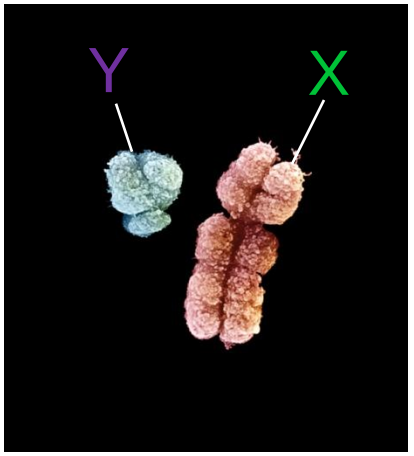


A few traits are **SEX-LINKED**. This means the gene for the trait is located on the **X** chromosome

- Compare the **X** and **Y** chromosomes below

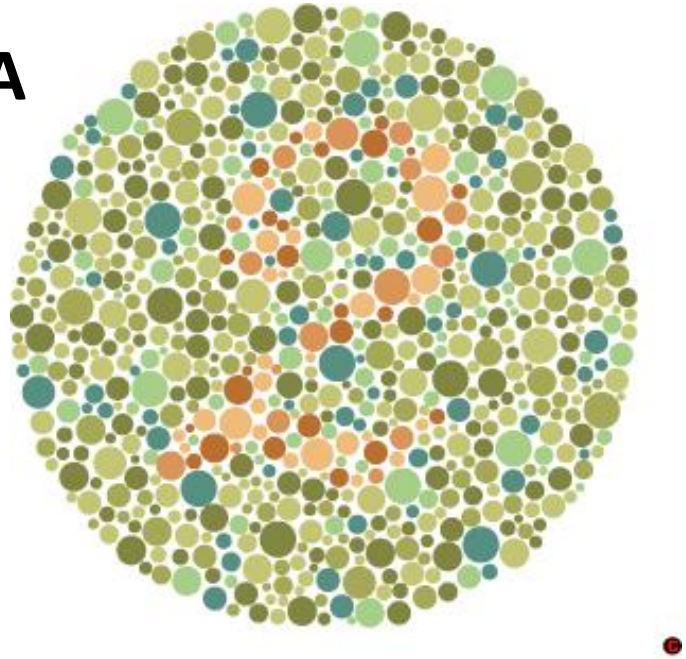




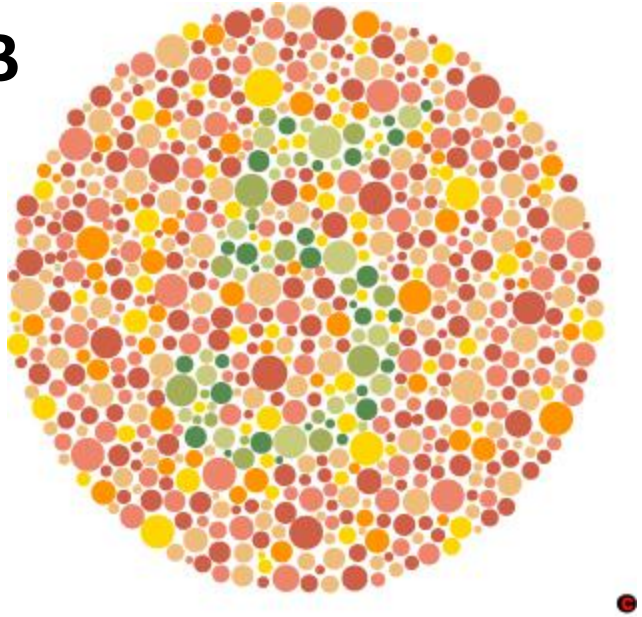


- If females are **XX** and males are **XY**, how do you think recessive disease mutations affect girls vs boys ???
- Let's check the class for a common sex-linked mutation

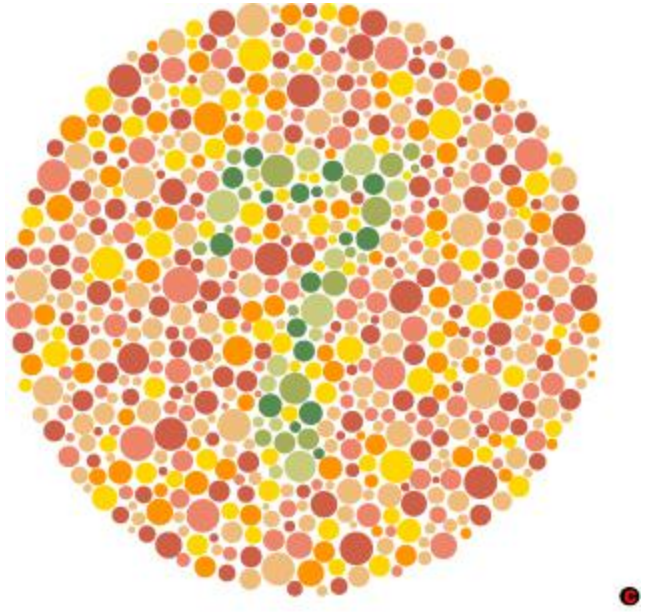
A



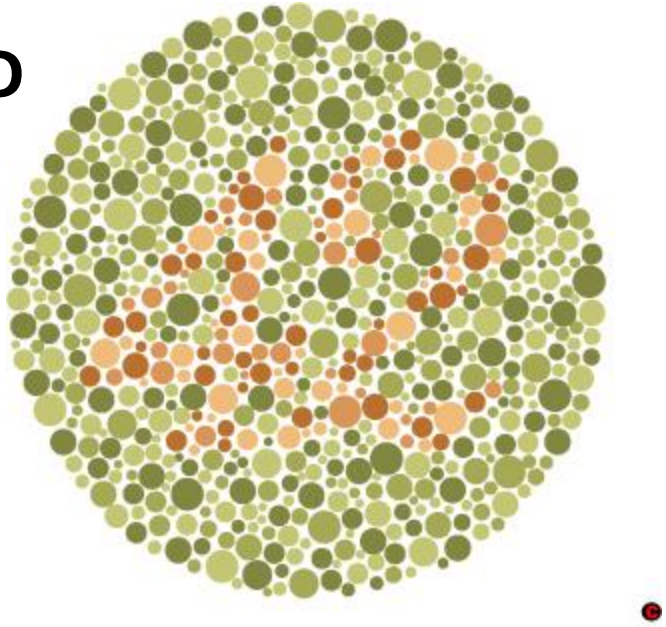
B



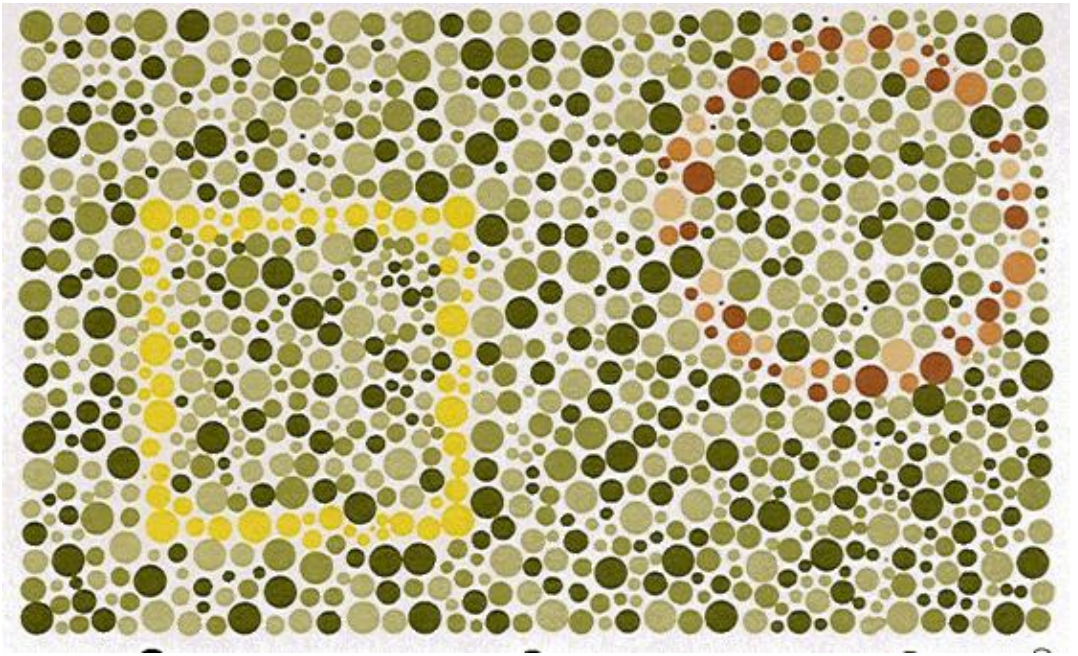
C



D



E



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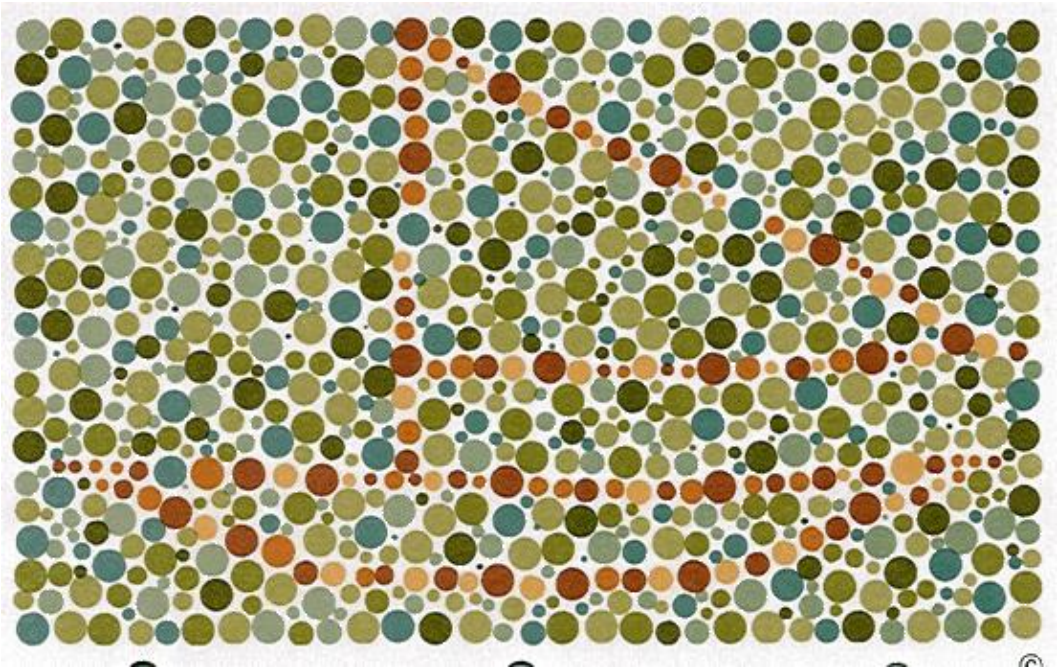
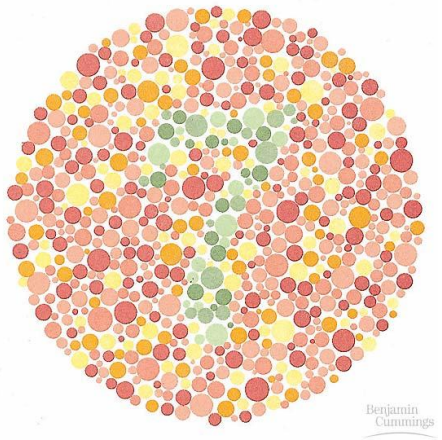


Notice any difference?

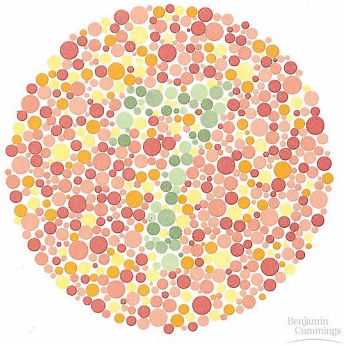
Sex-linked genes affect males and females in __different__ ways:

- **__Color blindness__** is a sex-linked trait caused by a recessive mutation (**__b__**= colorblind allele)
- Males → Alway show the sex-linked trait if inherited (X^bY)
- Females → Rarely show CB, only when **homozygous** (X^bX^b)

  → Most females are health but could be:
  - **Heterozygous** y carrier (X^BX^b)
  - **Homozygous** (X^BX^B)



Let's Review:



- Sex-linked disorders affect mostly **males**
- Females are often healthy **carriers**
- Most sex-linked human disorders are due to **recessive** alleles
  - Examples: **Color blindness**, **hemophila**, **Muscular dystrophy**
- A male receives a single X-linked allele from his **mother**, and will have the disorder, while a female has to receive the allele from **both parents** to be affected
- Trait is NEVER passed from **father** to son

Duchenne Muscular Dystrophy is a Sex-Linked Disease

- *Extraordinary Measures* is a 2010 movie about a family's quest to find a cure for their kids who have a form of MD called Pompe Disease

Let's try a sex-linked Punnett Square

Jim is not colorblind and neither is his wife, Mary. However, because Mary's dad WAS colorblind, she is heterozygous for red-green colorblindness.

	Genotypes
Jim	$X^B Y$
Mary	$X^B X^b$

	X^B	X^b
X^B	X^BX^B	X^BX^b
Y	X^BY	X^bY

Will any children be colorblind?

Many genes may interact to produce one trait.

- Polygenic traits are produced by two or more genes.

Order of dominance:
brown > green > blue.

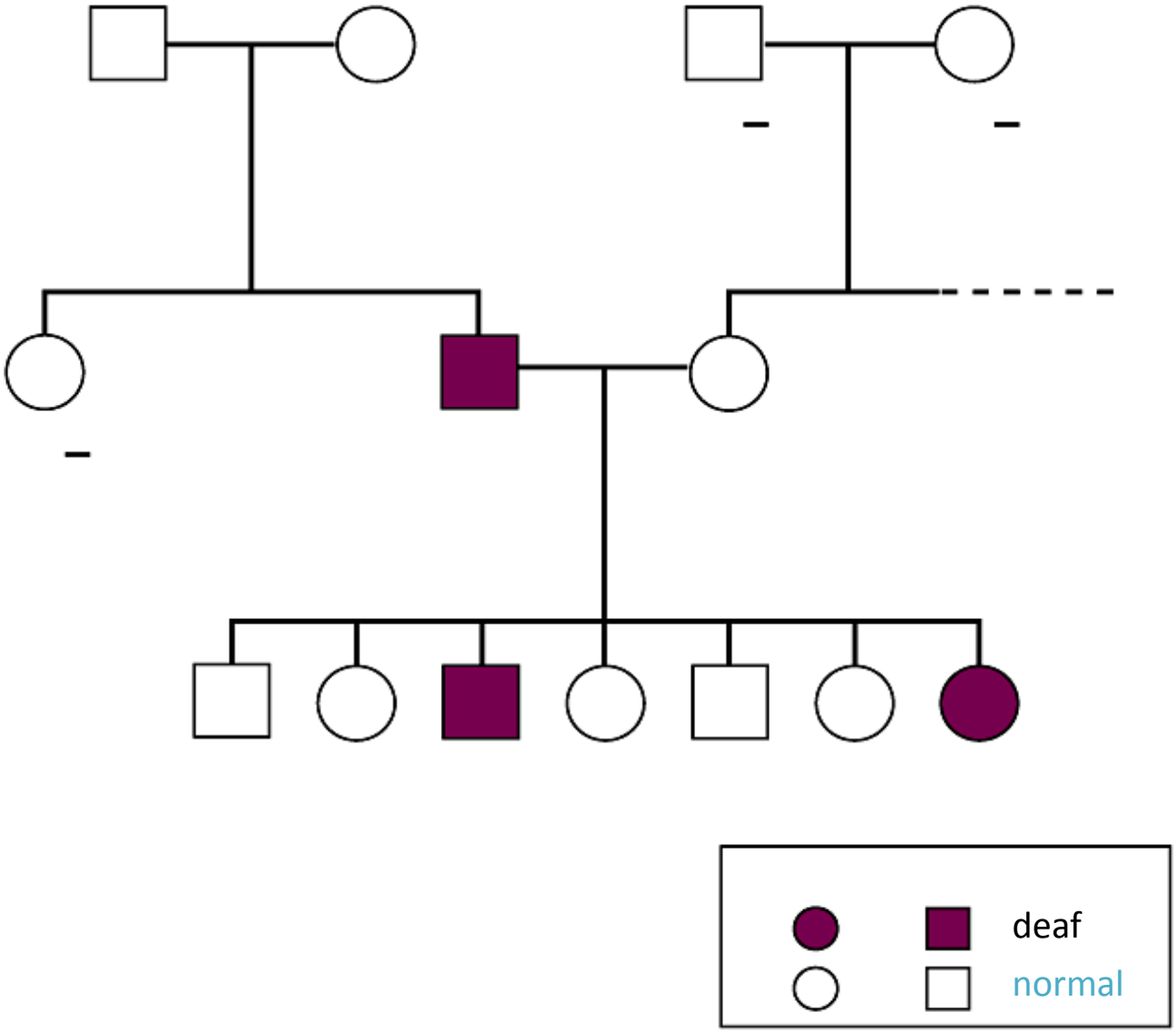
GENE NAME	DOMINANT ALLELE	RECESSIVE ALLELE
BEY1	brown	blue
BEY2	brown	blue
GEY	green	blue

Sometimes the environment directs how a gene is used

- Phenotype is a combination of genotype and environment.
- The sex of sea turtles depends on both genes and the nest temperature
- Height is an example of a phenotype strongly affected by the environment.

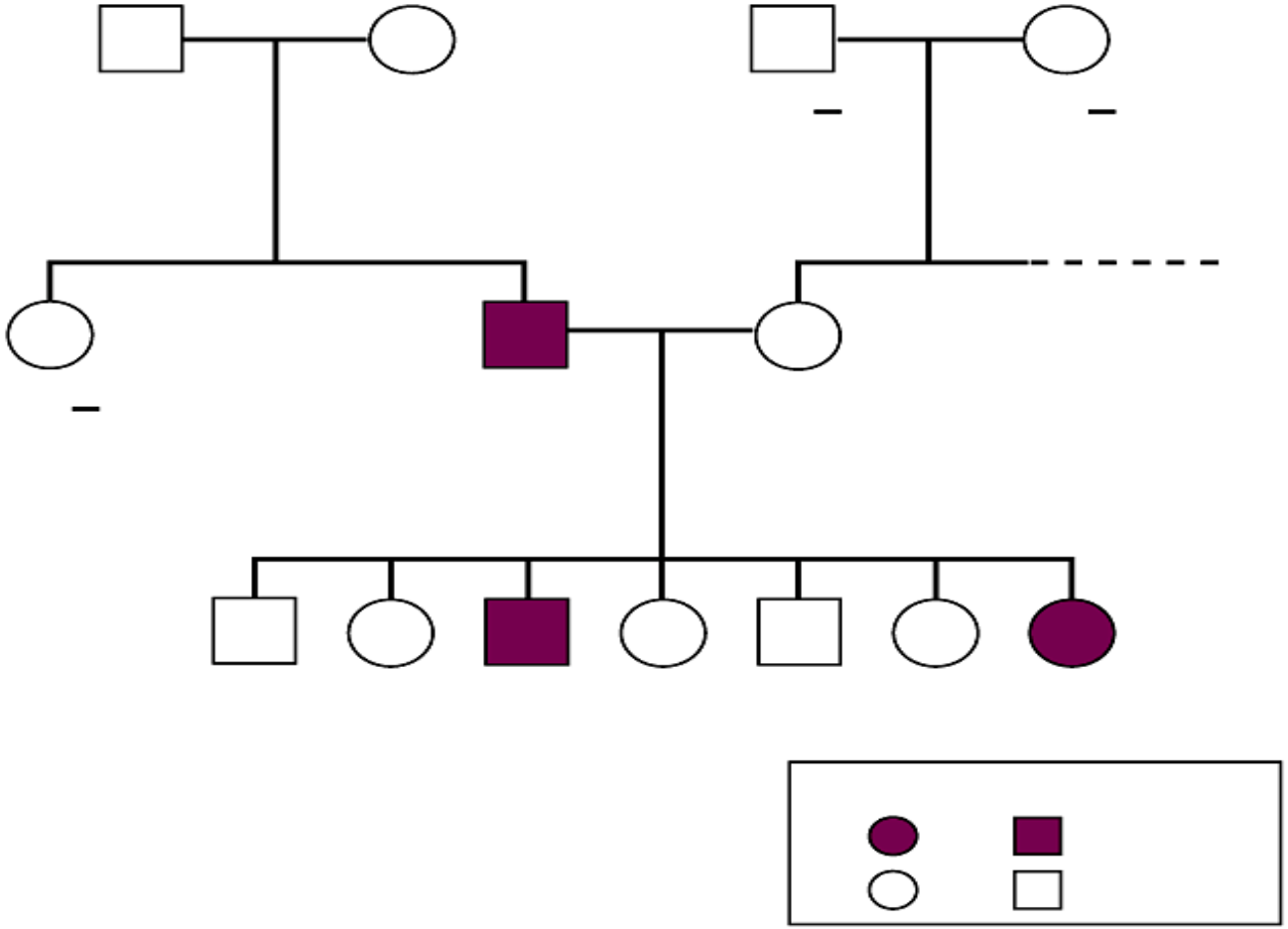
Topic 6: Pedigree Skills

Pedigree for Human Deafness



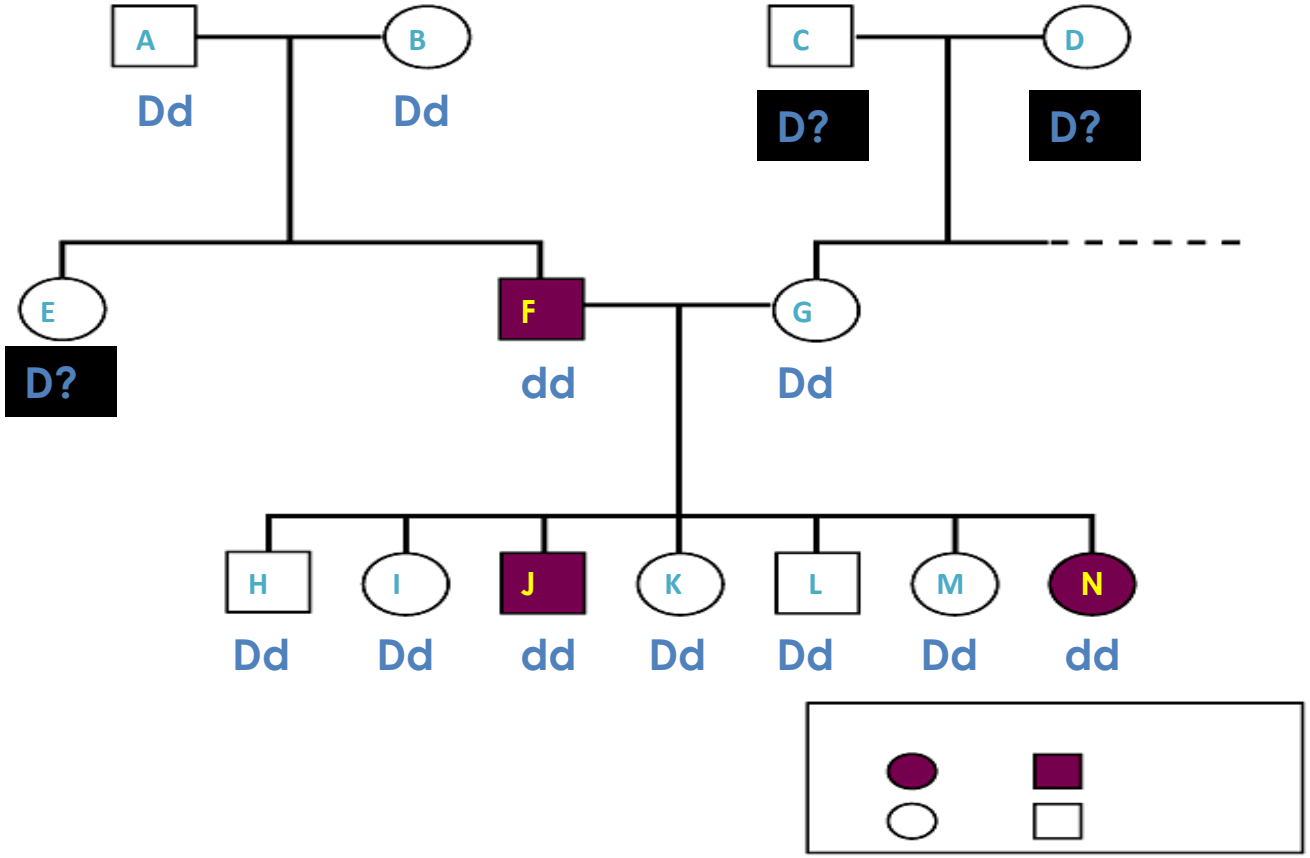
1) Is the trait Dominant or Recessive?

- **Dominant** hints: common? 2 sick parents have a healthy kid?
- **Recessive** hints: rare? 2 healthy parents have a sick kid = skip generations?



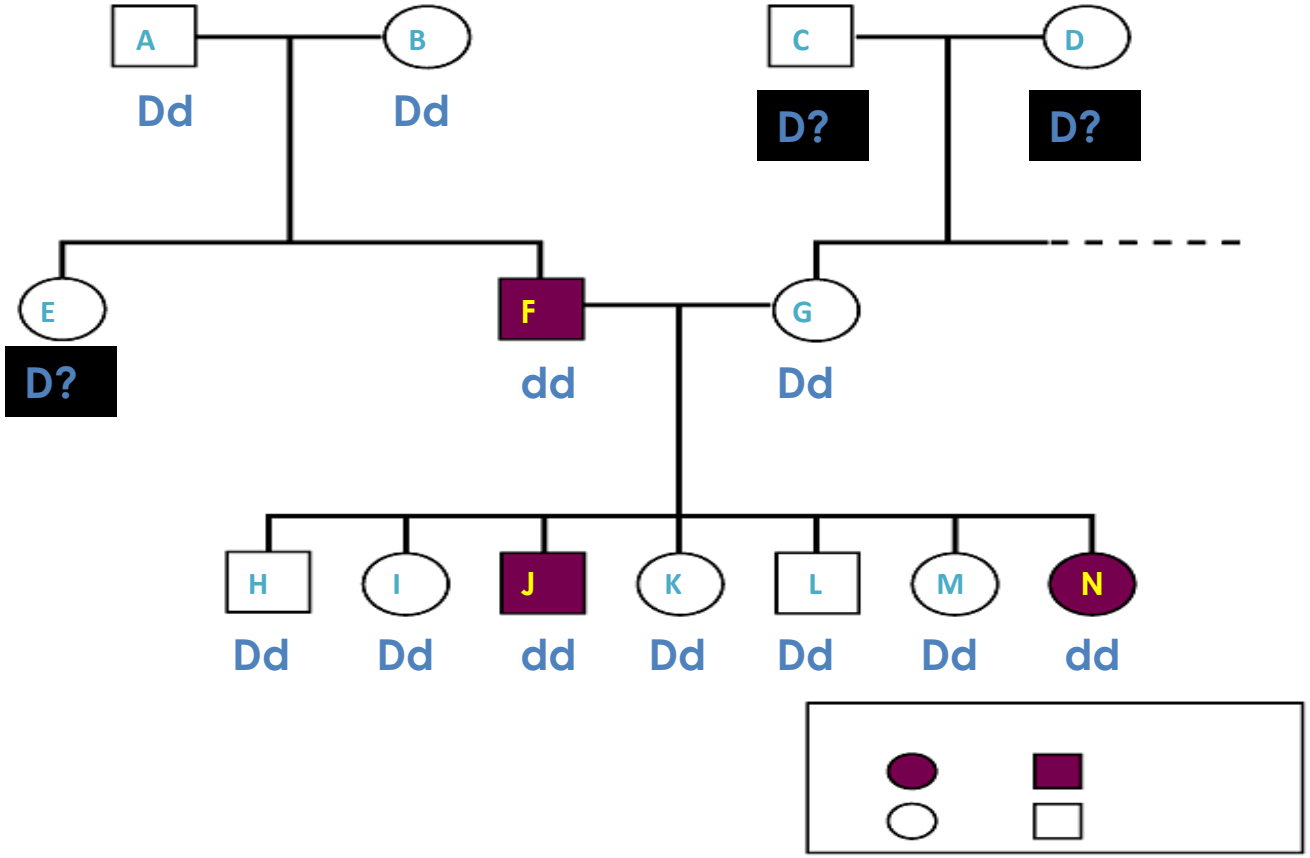
2) Write the **genotype** for each person

- HINT: always start with the ones who have 2 recessive alleles
- List all the persons who have a homozygous genotype?
  F J N
- List all the persons who could have more than 1 possible genotype? C D E

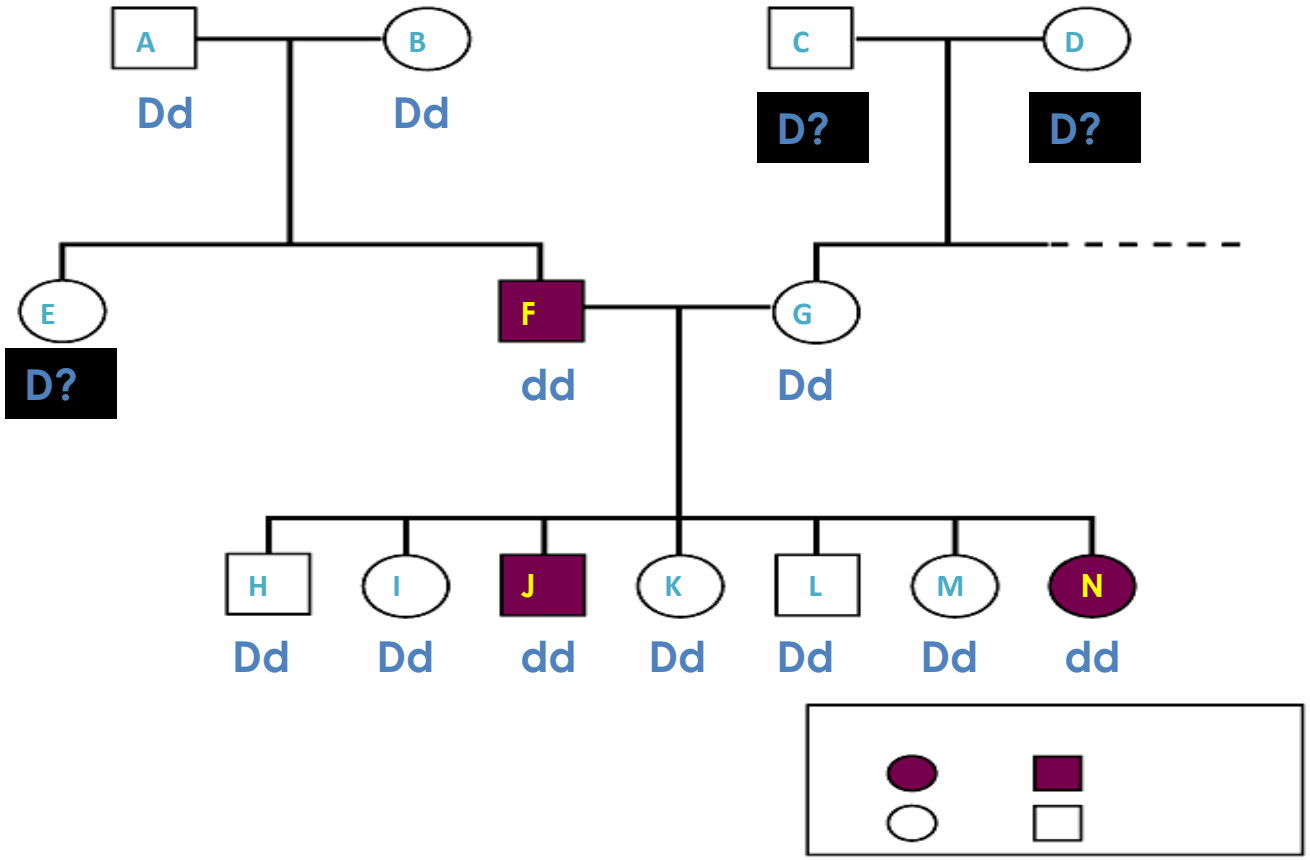


3) Determine the **Phenotype** for each person

- Person A = healthy
- Person F = deaf
- Person M = healthy

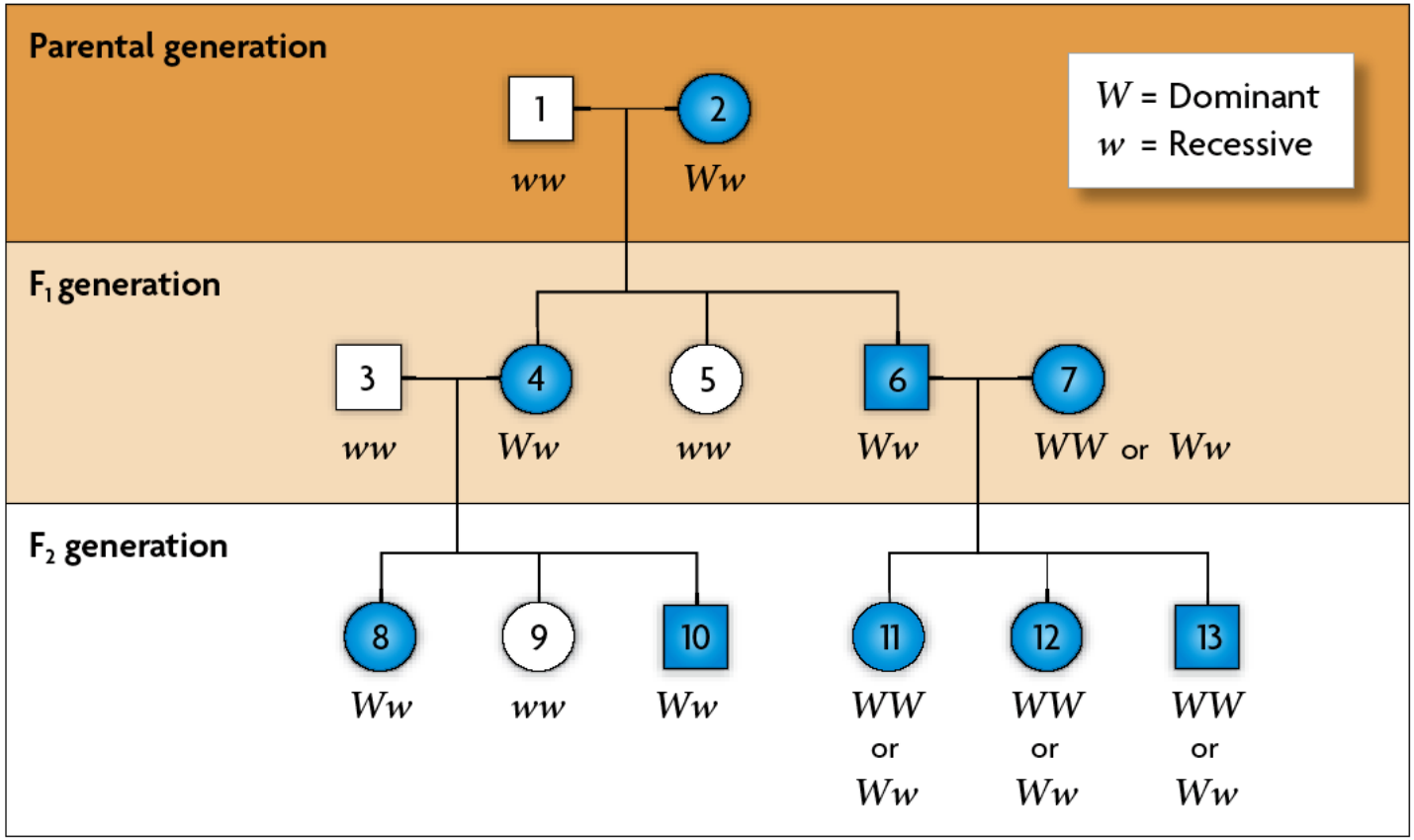


4) Determine the **chance** for parents A & B to have a deaf child? **1/4 = dd**

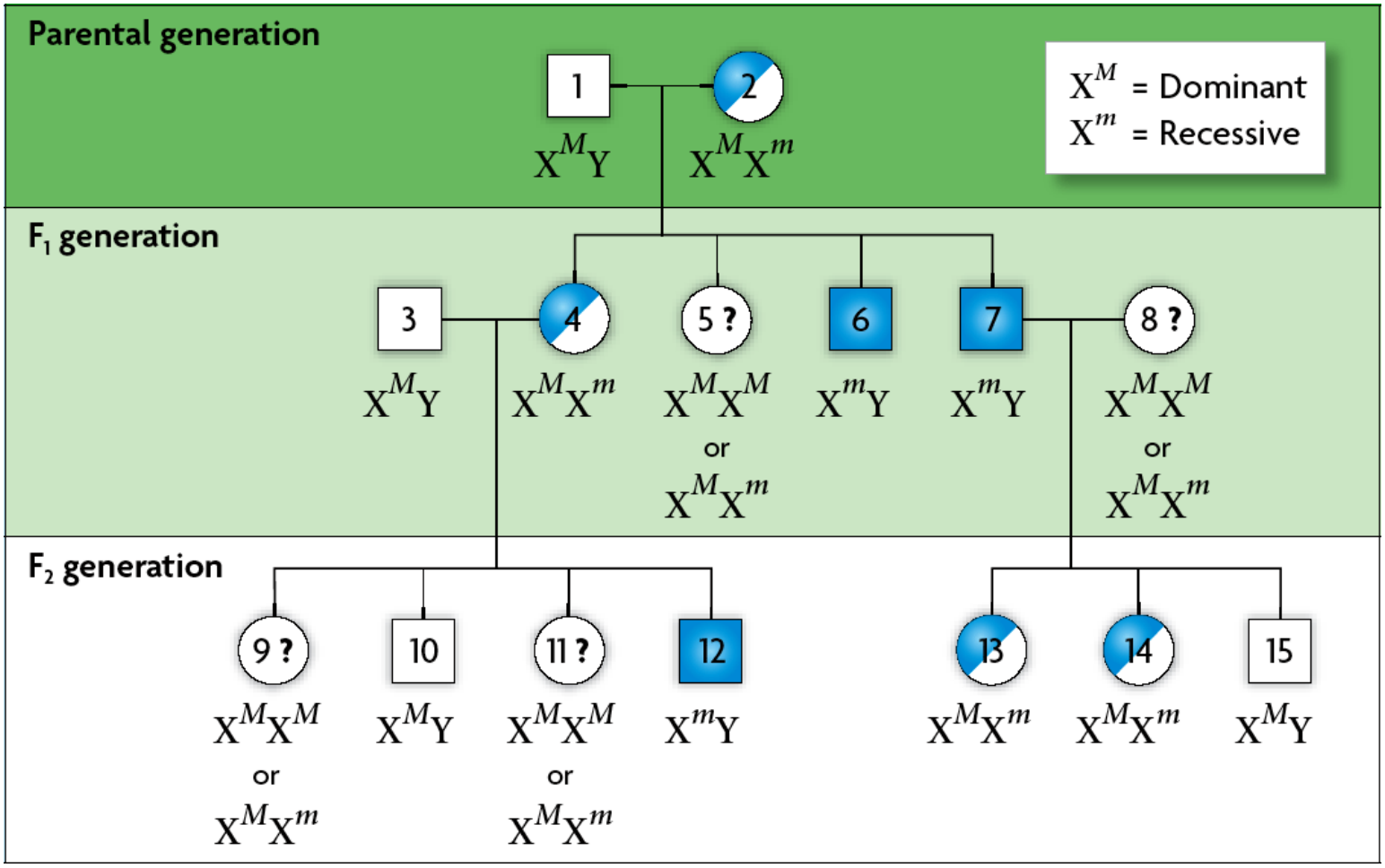


A pedigree is a chart for tracing genes in a family.

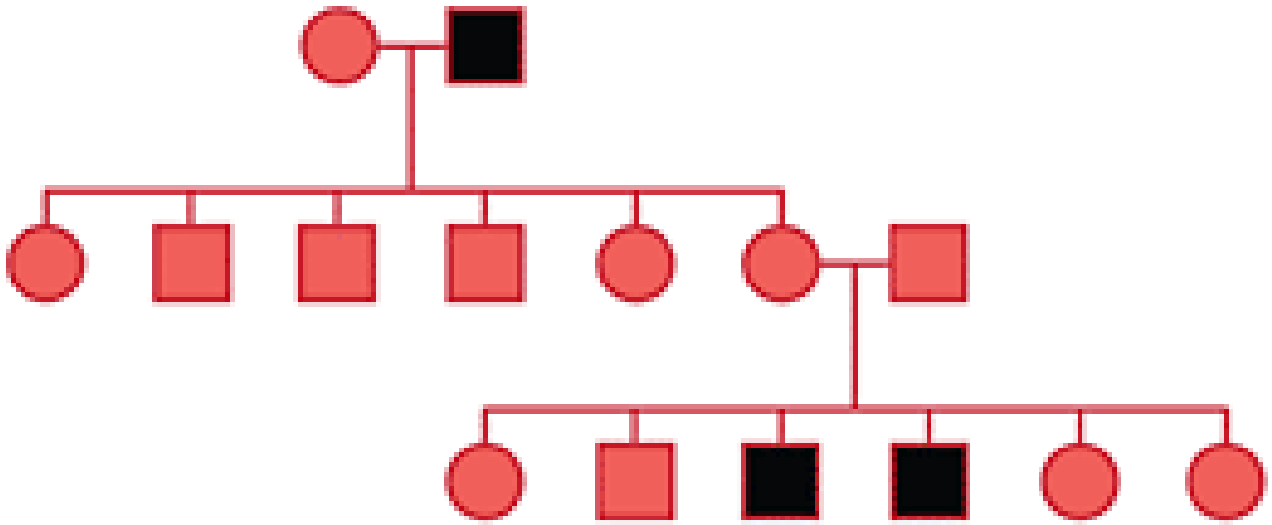
- Autosomal genes show different patterns on a pedigree than sex-linked genes.
- Is this trait **Autosomal** or **Sex-linked** ???



Is this trait **Autosomal** or **Sex-linked** ???

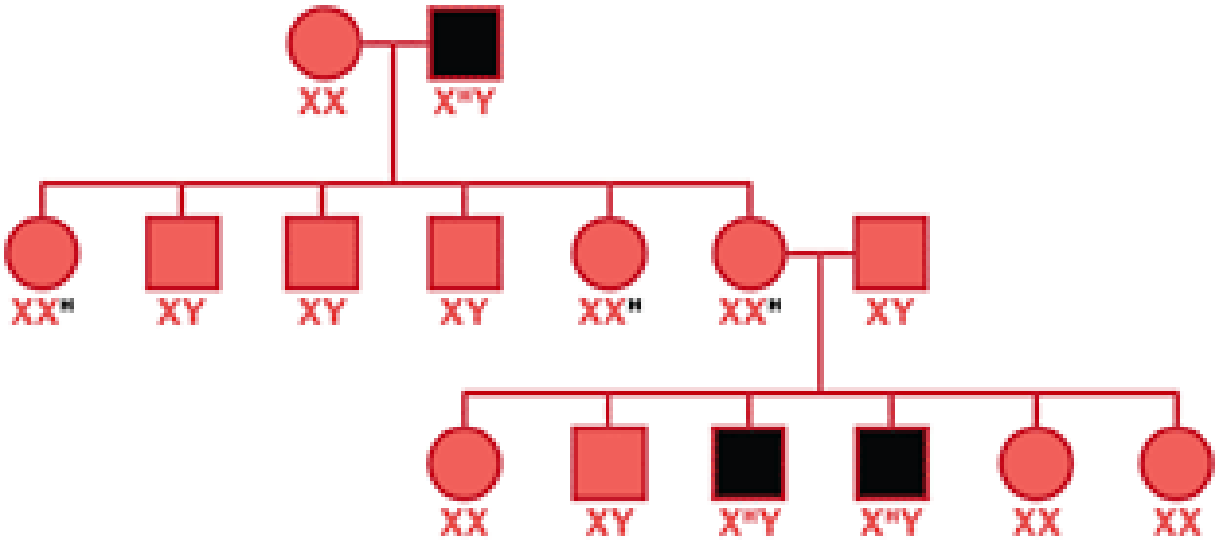


Is this trait **Autosomal** or **Sex-linked** ???



Hemophilia: Father-Daughter Relationship

- All daughters of an affected father receive an X chromosome with the "H" allele.



- A high incidence of hemophilia (another sex-linked disease) has plagued the royal families of Europe

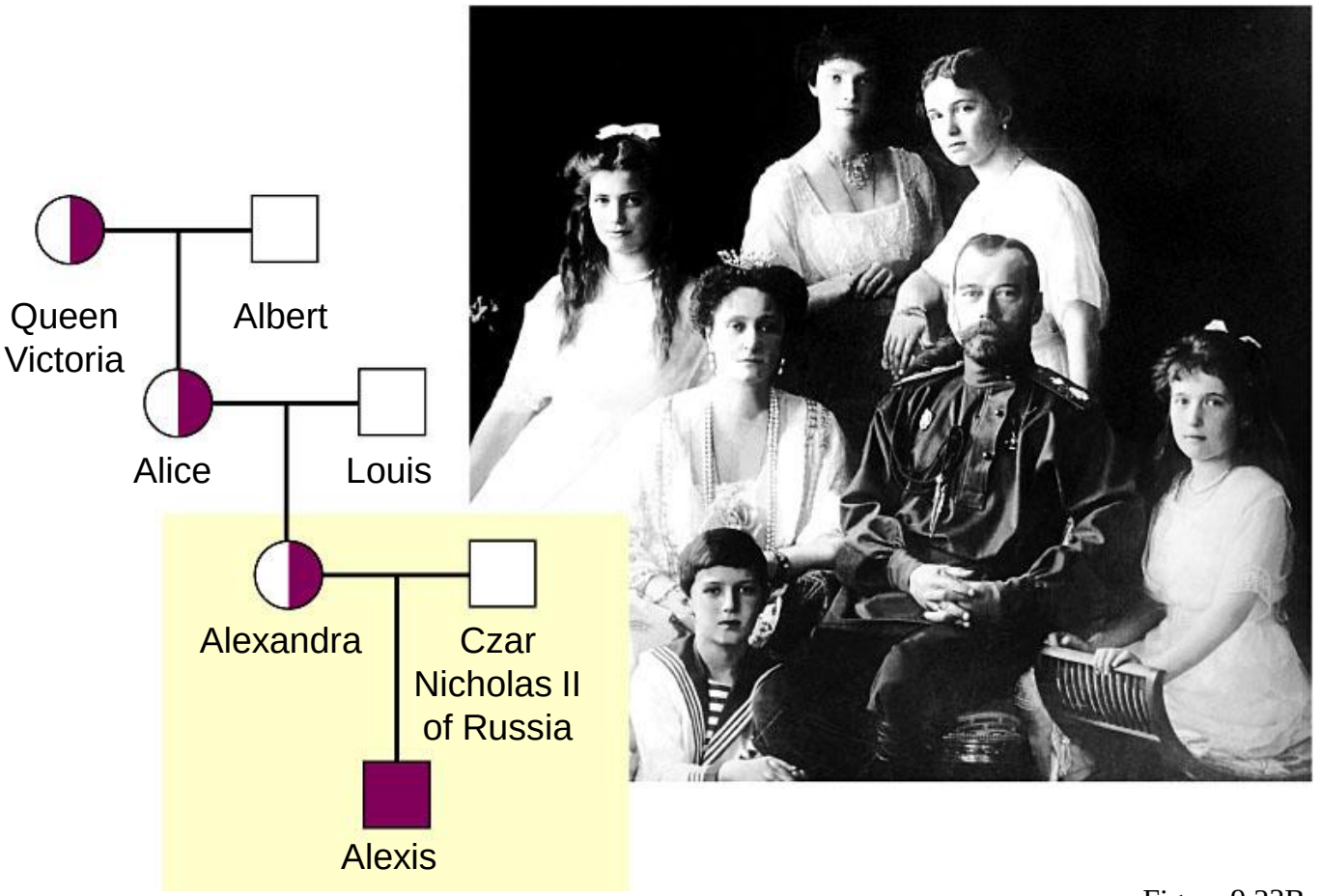
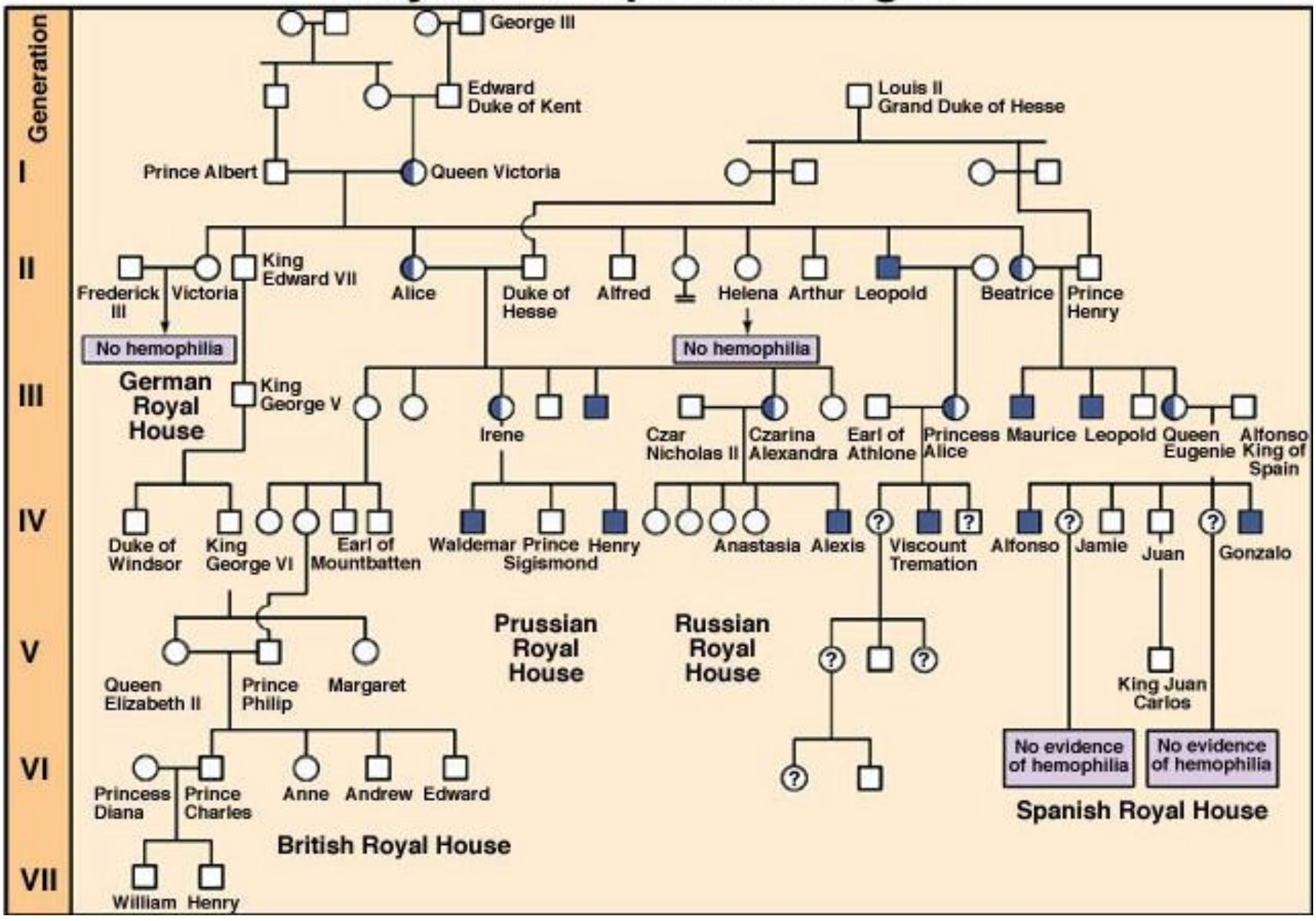


Figure 9.23B

Queen Victoria and Descendants

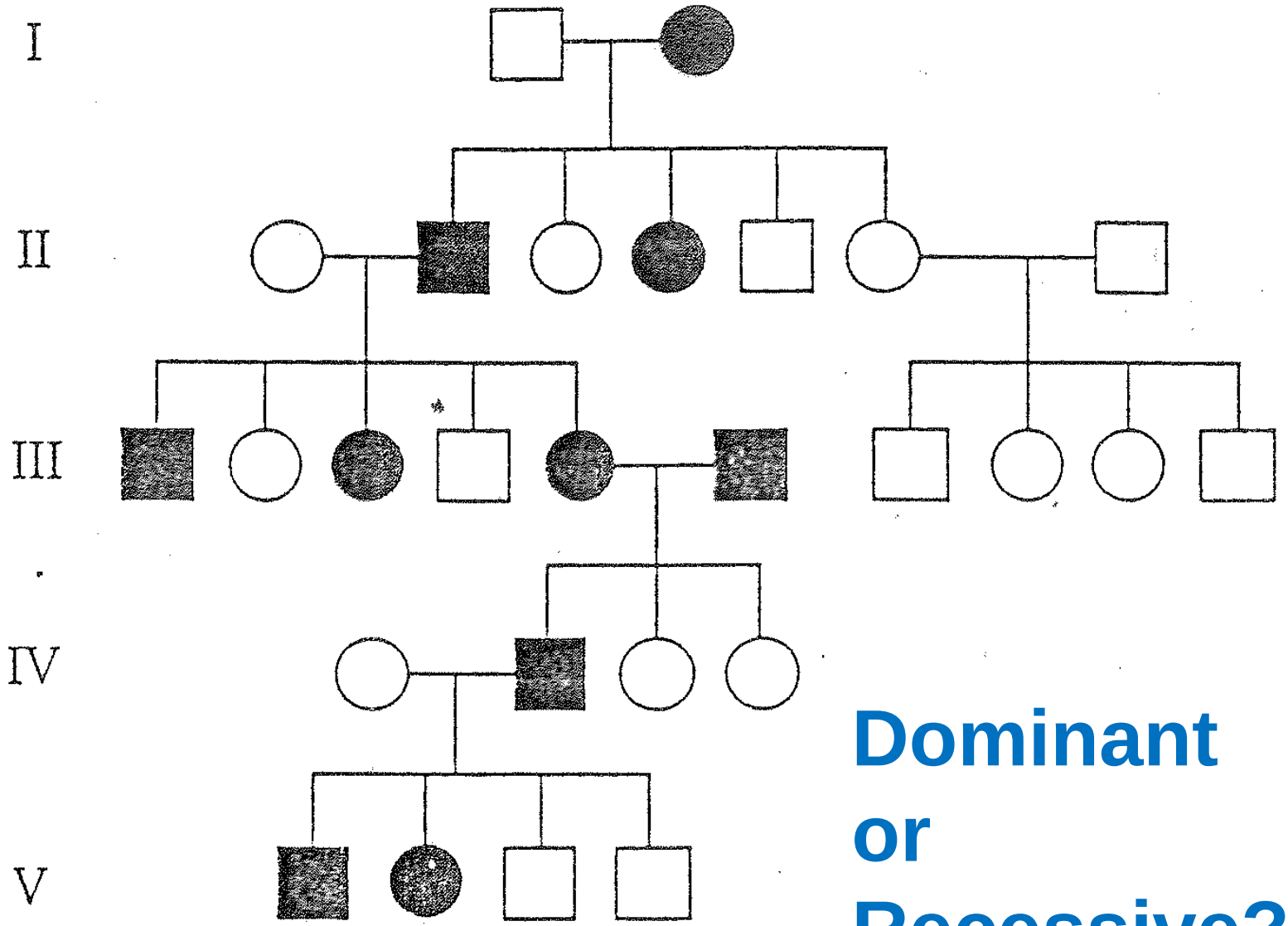
Royal Hemophilia Pedigree



Pedigree
PRACTICE

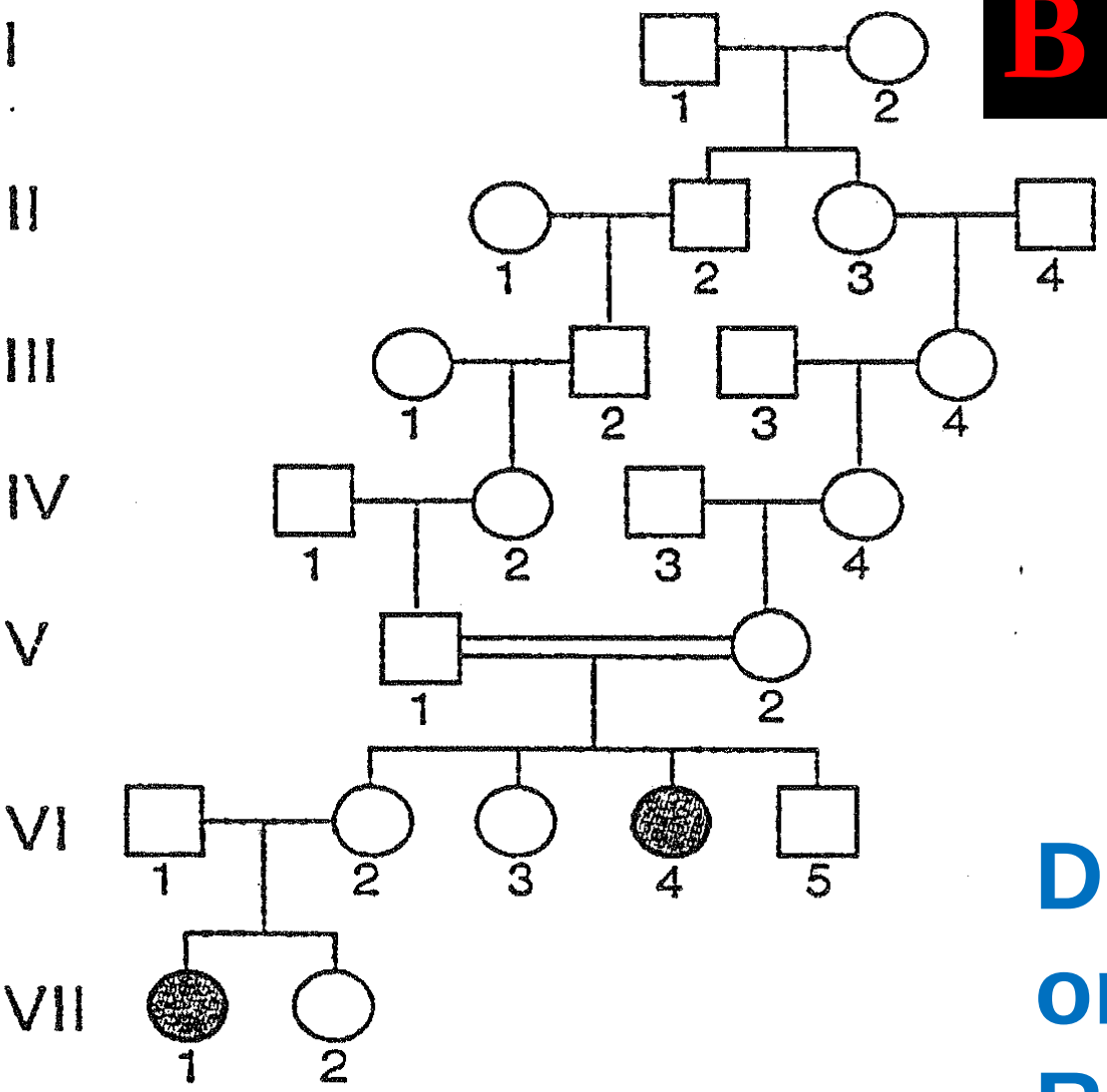
Generation:

Pedigree **A**



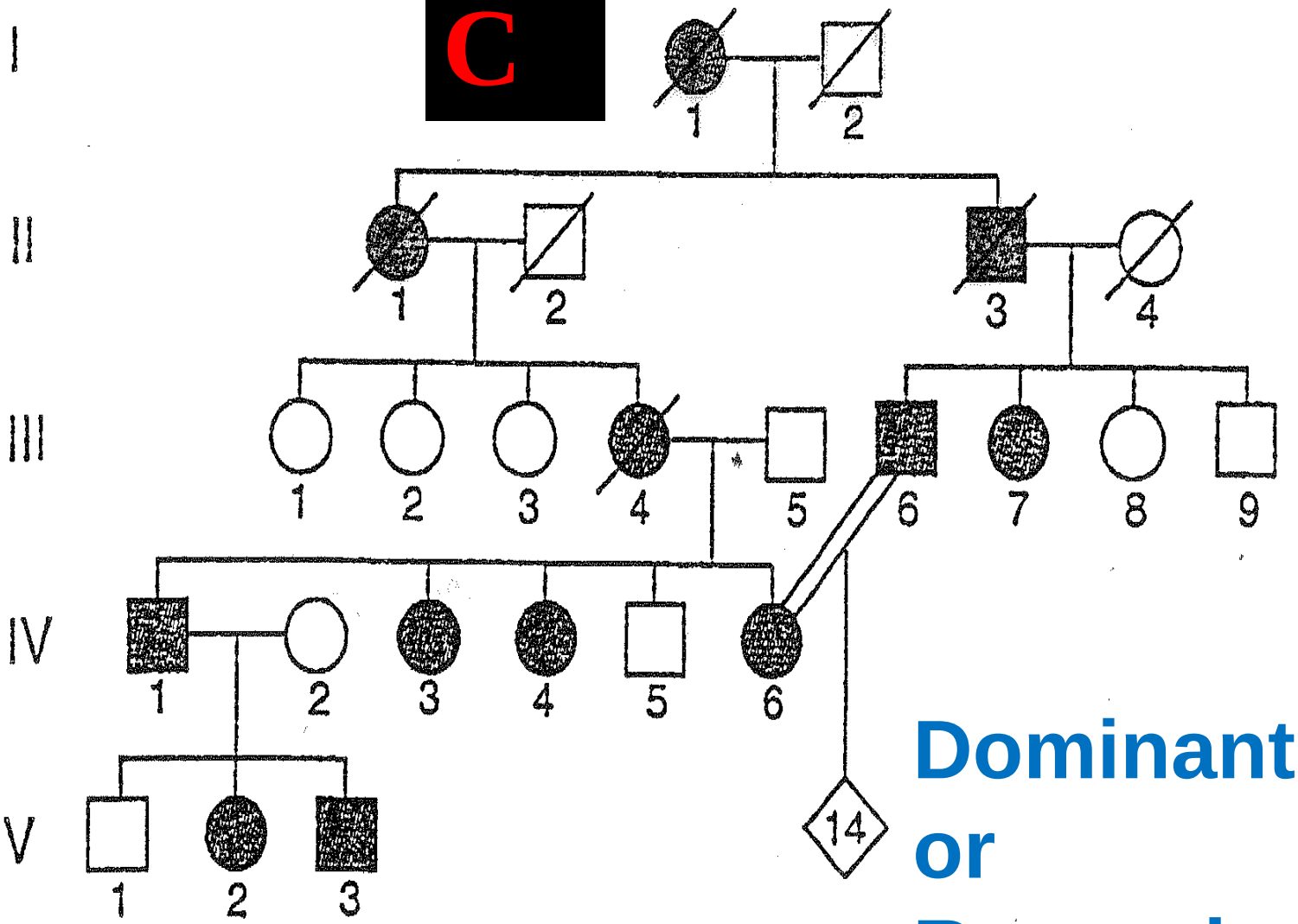
Dominant or Recessive?

B



Dominant or Recessive?

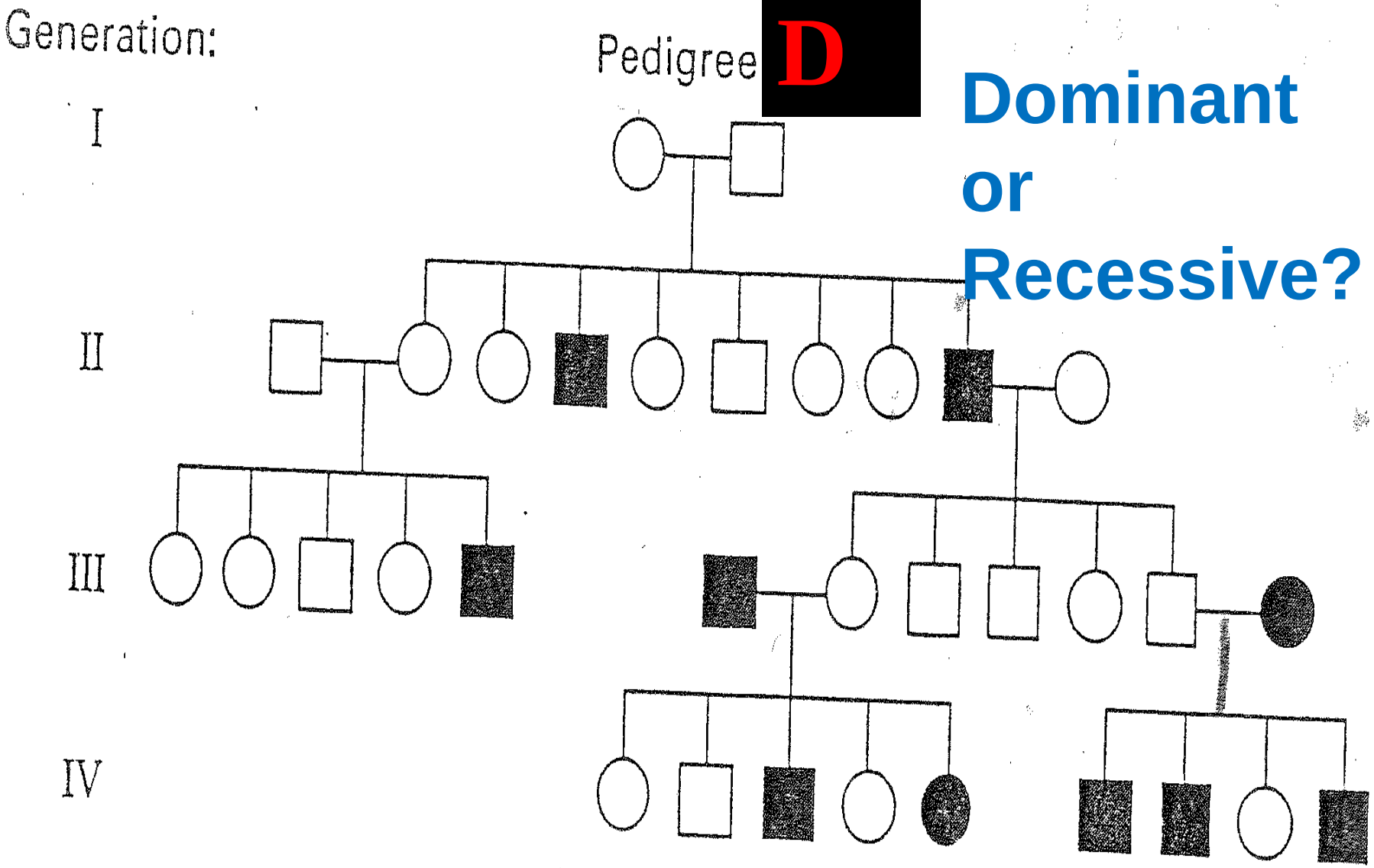
C



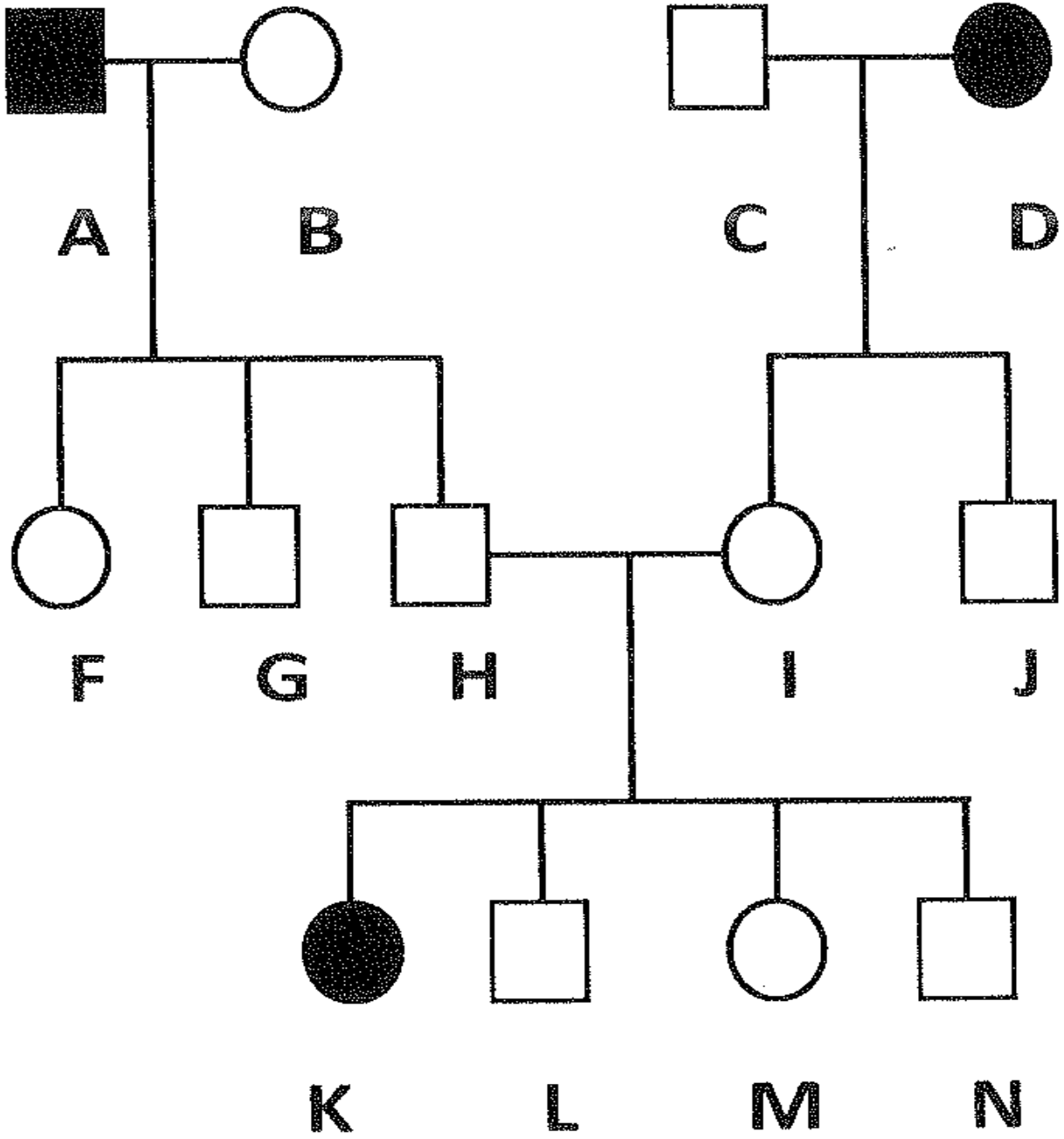
Dominant or Recessive?

Pedigree **D**

Dominant or Recessive?

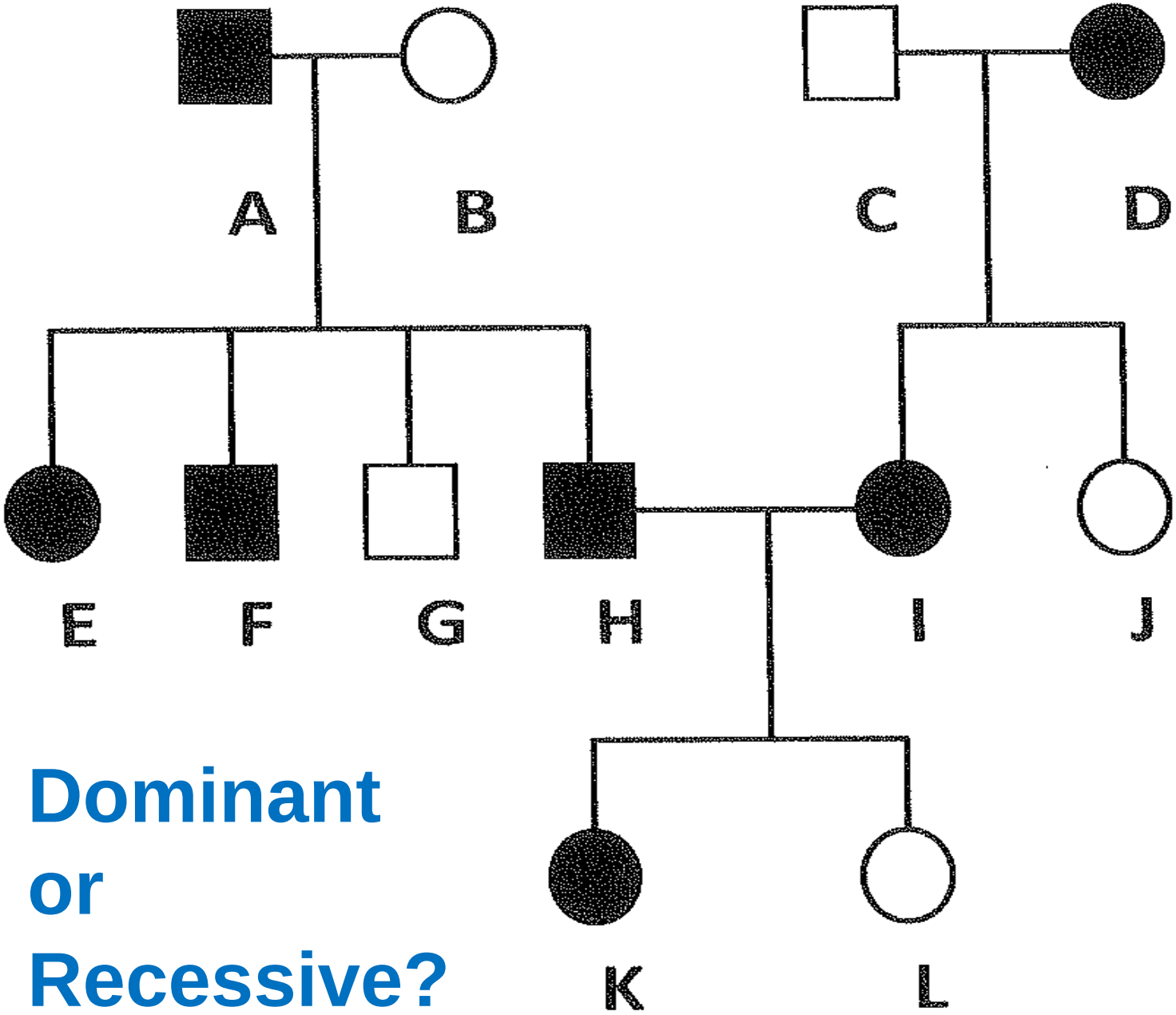


E



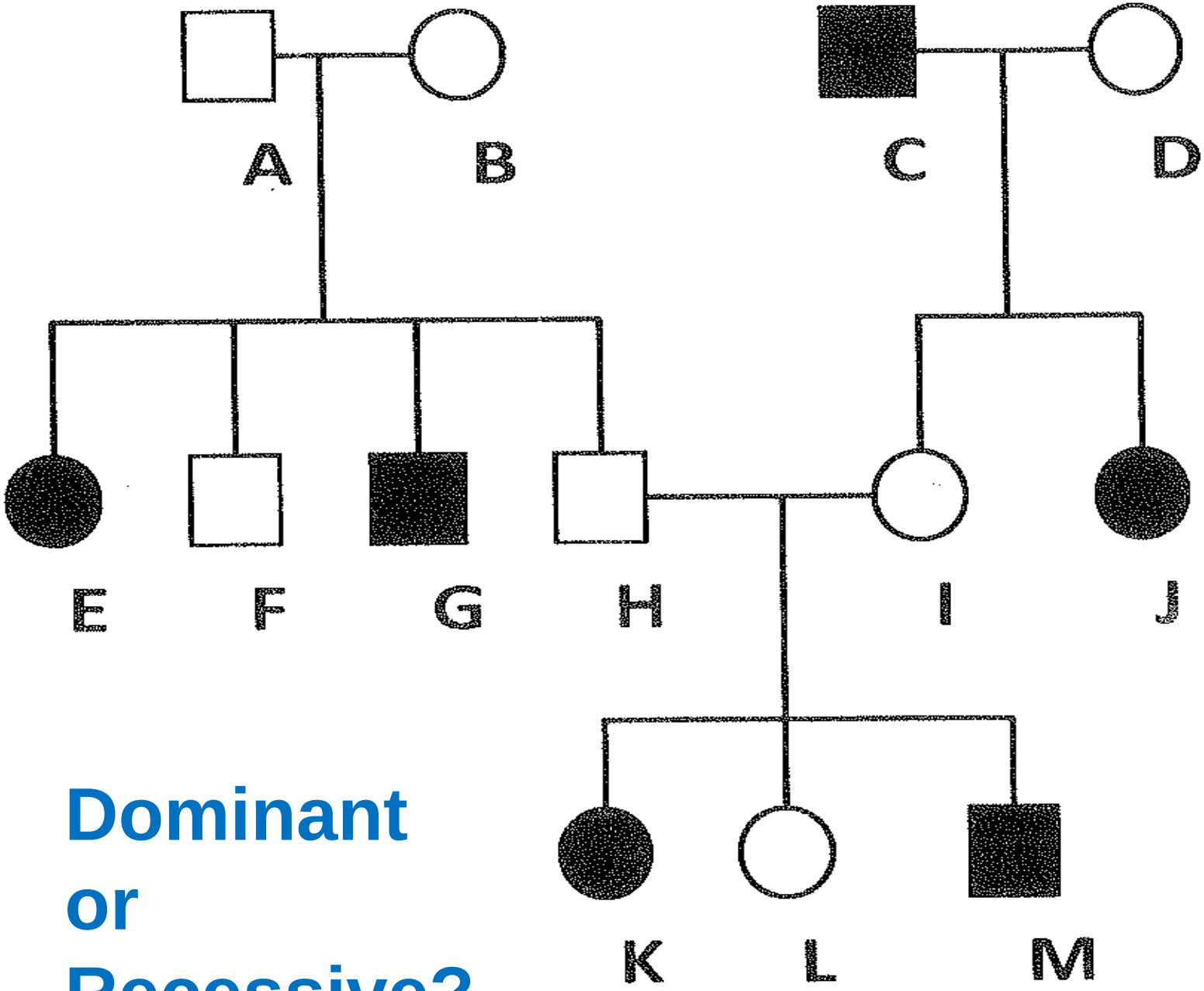
Dominant or Recessive?

F

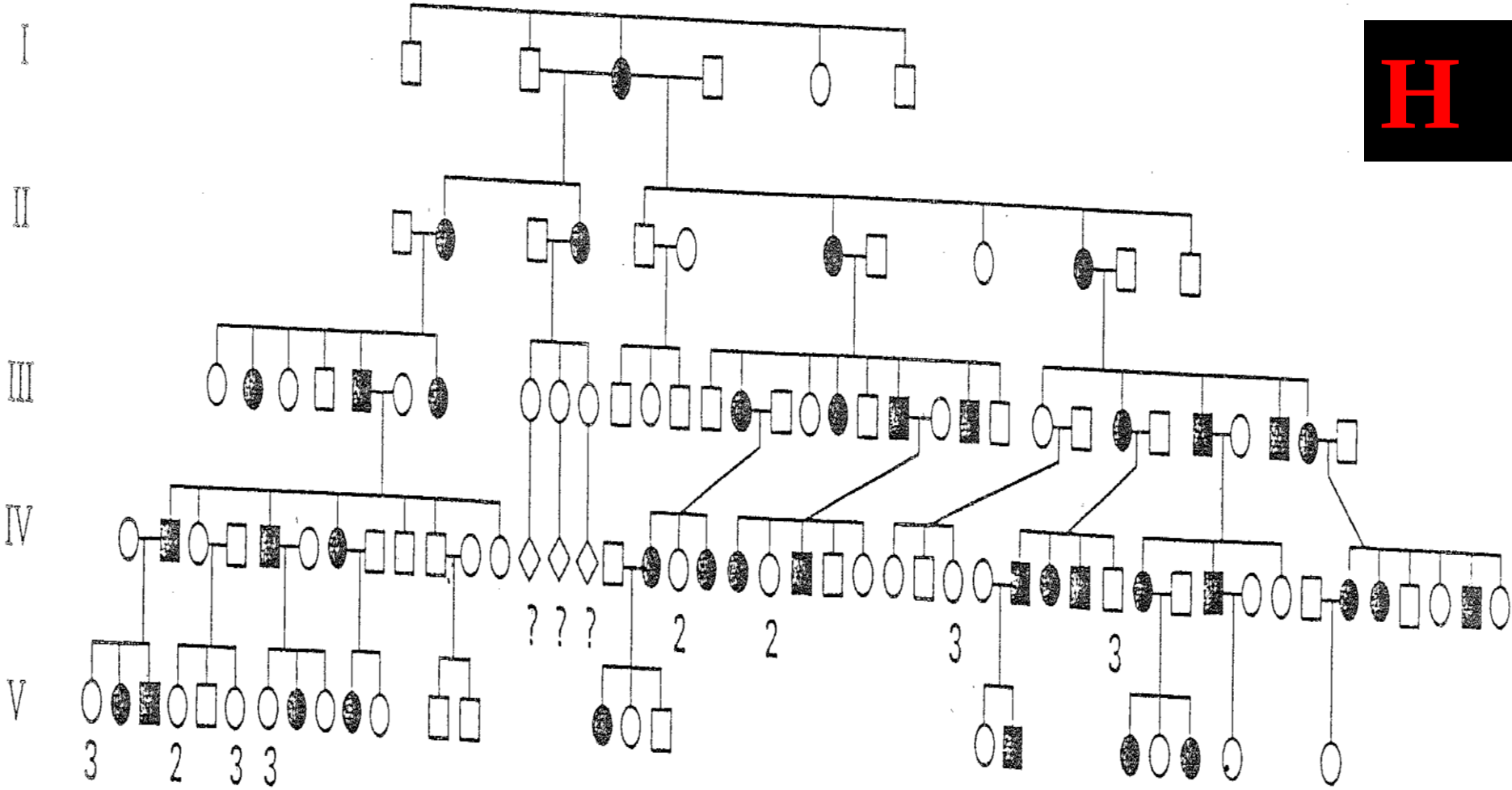


Dominant or Recessive?

G



Dominant or Recessive?



H

Dominant
or
Recessive?

Inherited Disorder Matching: Match each description to the corresponding inherited disorder

SCA = sickle-cell anemia
CF = cystic fibrosis
HD = Huntington disease
MD = muscular dystrophy

1 HD Treatments include implanting healthy young brain cells from aborted human or pig embryos

2 MD Affects boys more often than girls

3 SCA Symptoms include blood clots, strokes, seizures, pain, and weakness due to blocked capillaries

4 SCA Exercise causes the hemoglobin molecules to clump, changing the red blood cells into a sickle shape

5 CF Treatments include vapor inhalers with moist, medicated air; daily “drumming” therapy, and possibly gene therapy with an Ebola / HIV virus taken by an inhaler

6 MD Treatments include steroid injections, and possibly gene therapy or stem cell injections to stimulate healthy new muscle growth

SCA = sickle-cell anemia
CF = cystic fibrosis
HD = Huntington disease
MD = muscular dystrophy

7_____ Thick, dry mucous in the lungs leads to symptoms of coughing, wheezing and lung infections

CF

8_____ Symptoms include progressive loss of muscle function leading to wheelchair use when young

MD

9_____ Caused by a dominant mutation which leads to abnormal brain cell proteins and the gradual deterioration of the brain cells that control movement

HD

10_____ Treatments include blood transfusions and surgical transplants of bone marrow or stem cells from umbilical cords

SCA

11_____ Caused by a recessive mutation which gives heterozygous carriers protection from malaria

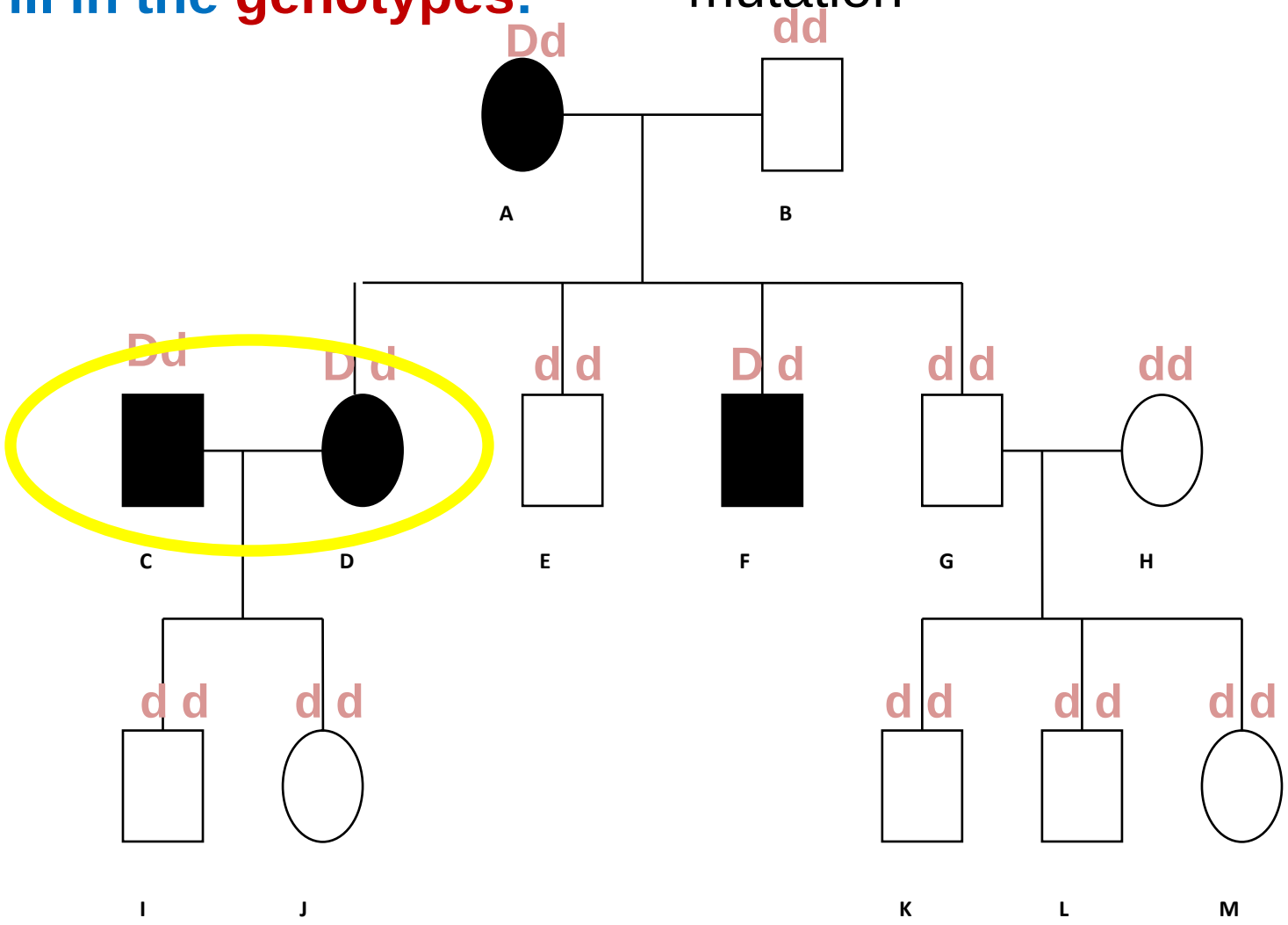
SCA

Study Guide Pedigree #1

Dominant or recessive ?

D = mutation

Fill in the genotypes:

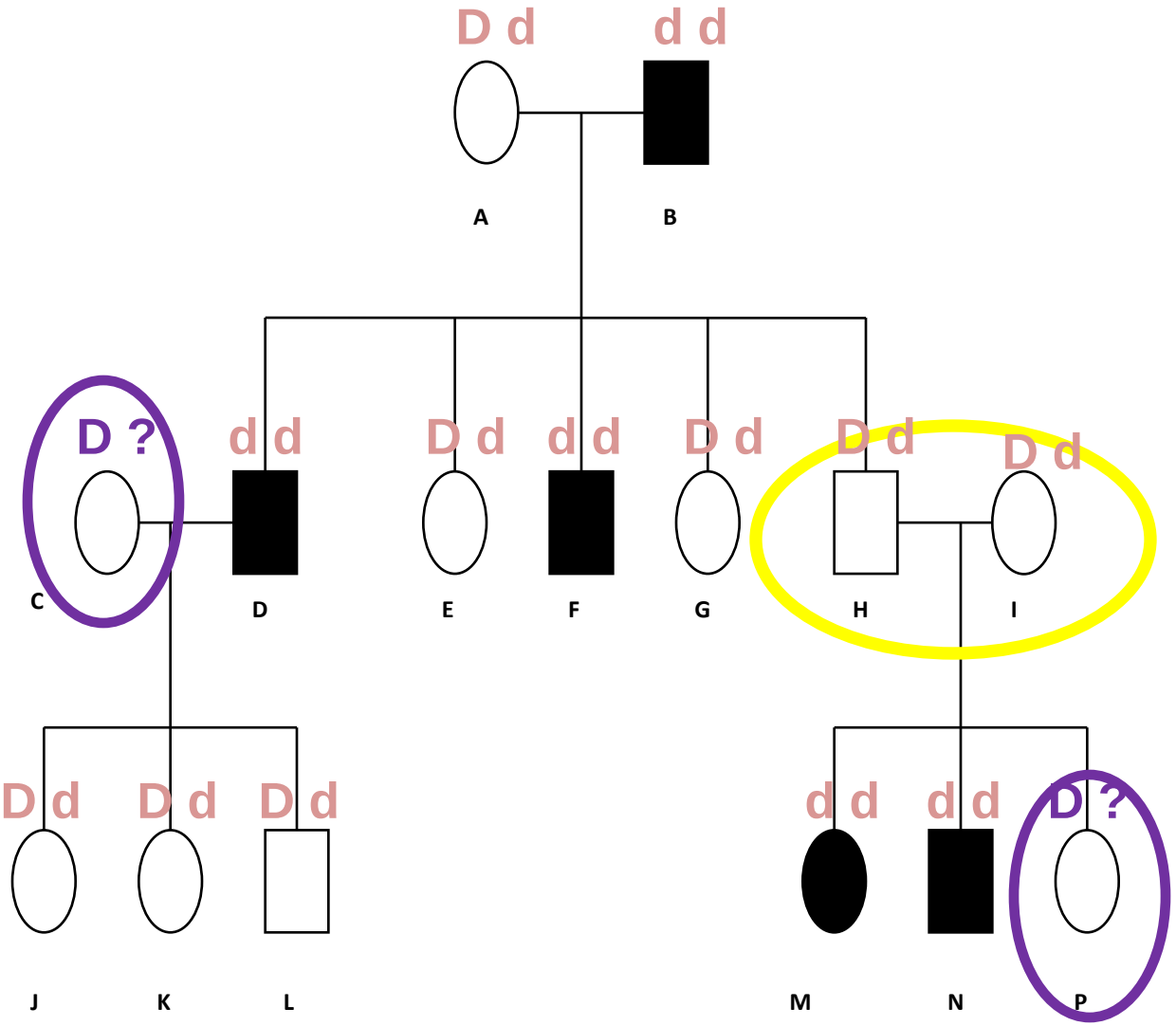


Study Guide Pedigree #2

Dominant or recessive ?

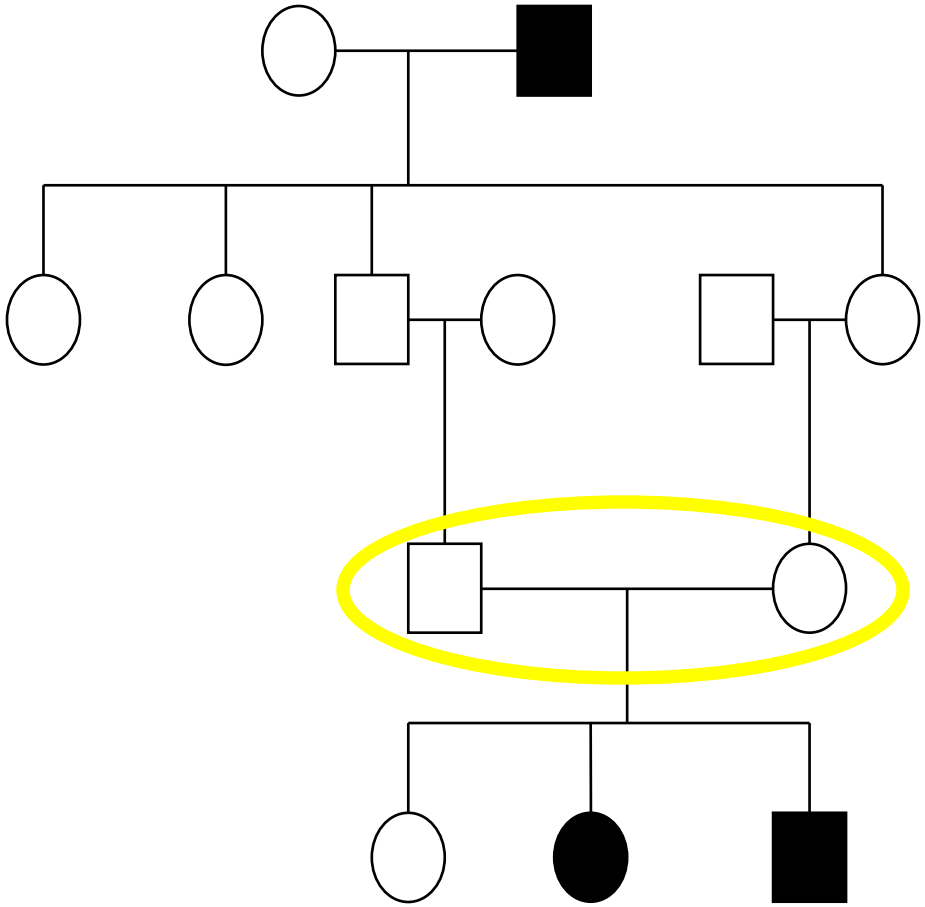
d = mutation

Fill in the genotypes:



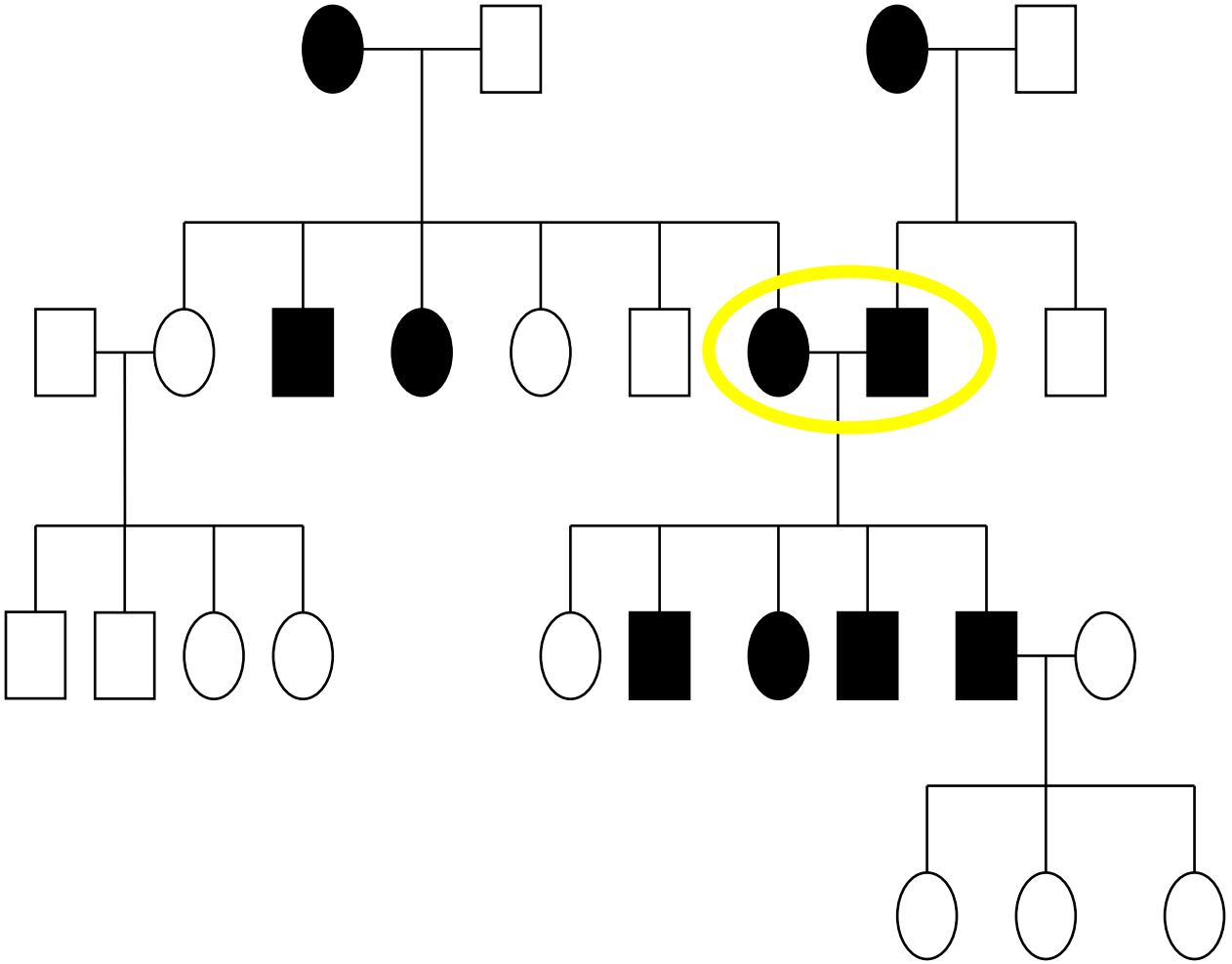
Study Guide Pedigree #3

Dominant or recessive ?

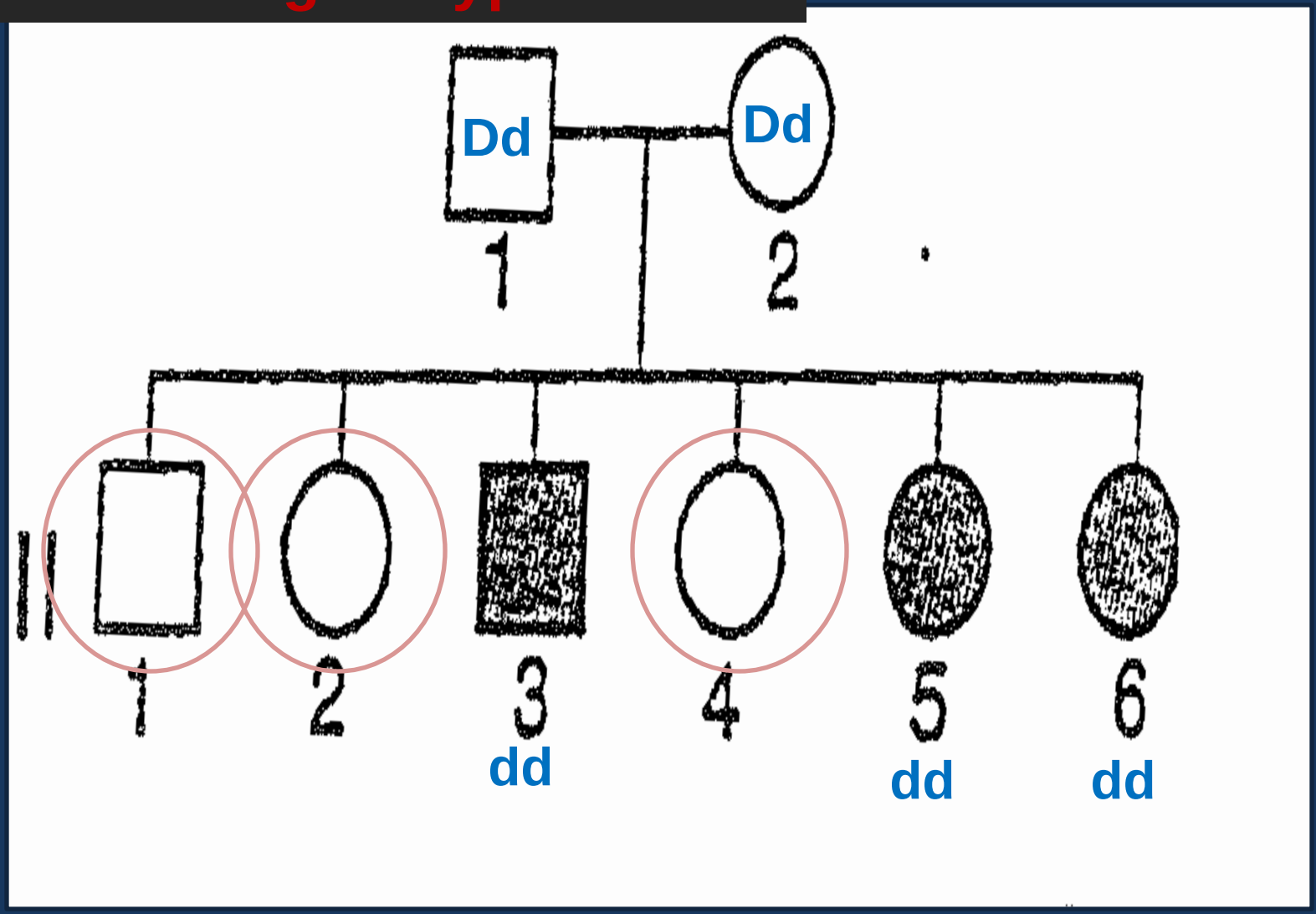


Study Guide Pedigree #4

Dominant or recessive ?

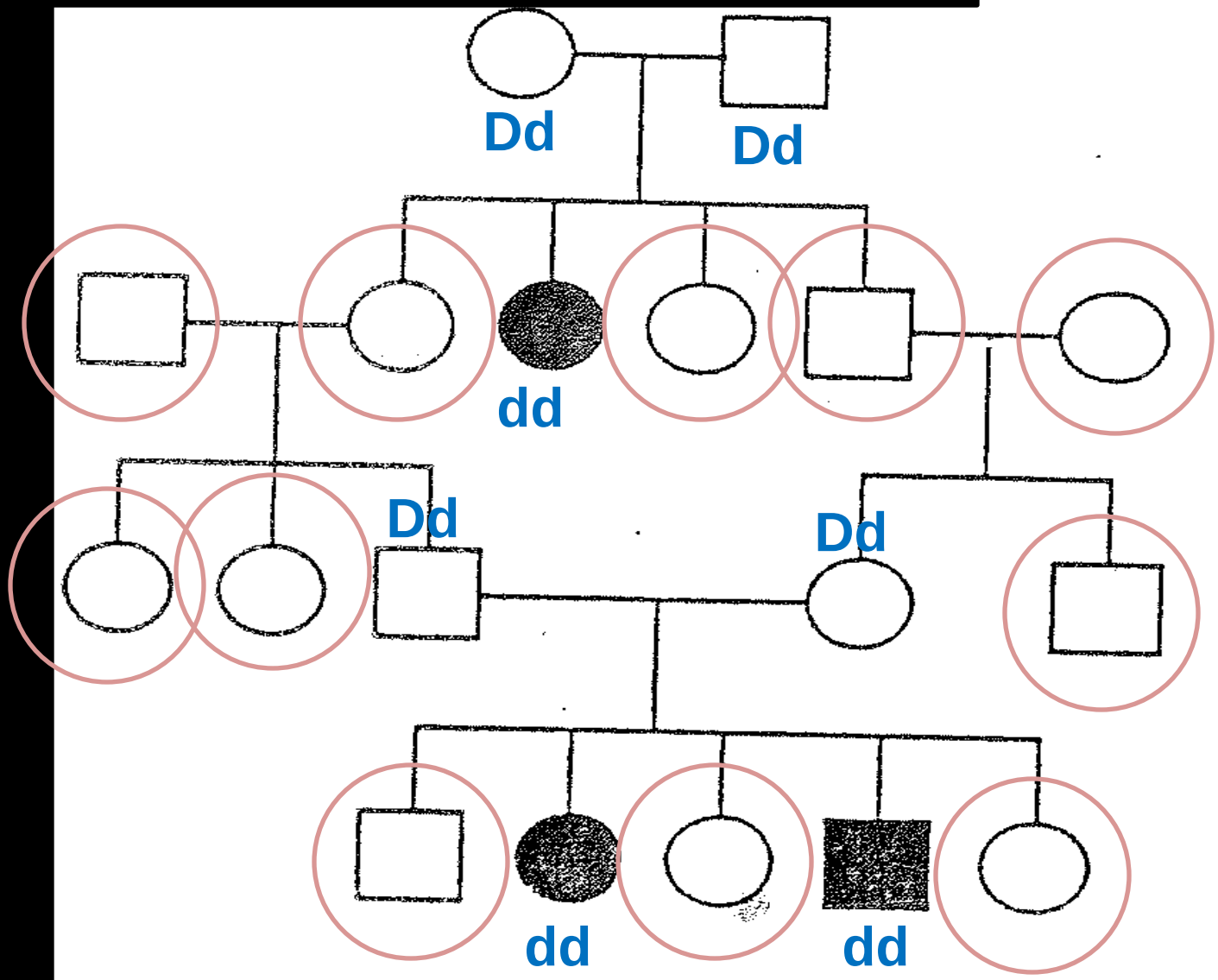


Dominant or recessive?
Fill in the genotypes



Dominant or recessive

Fill in the genotypes:



Dominant or recessive ?

Fill in the genotypes: