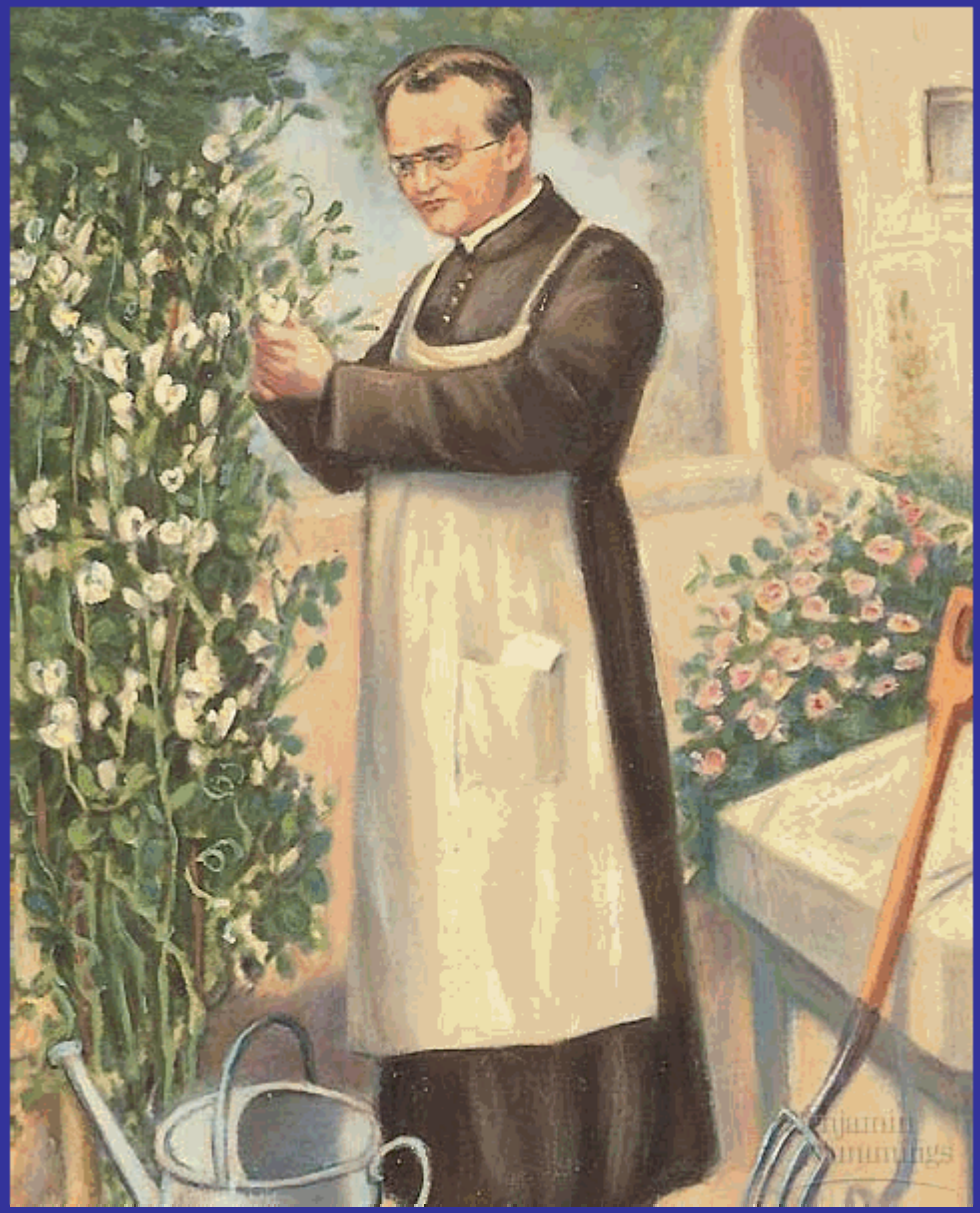
Listen: I'm My Own Grandpa

On Wed., March 19, we'll review material covered so far in this class. You'll get most out of this review by trying to answer questions ahead of time. The questions begin with Slide #71

Site of Mendel's experimental plot / garden, 1856-1865 :

Gregor Mendel,
Brno, Czech
Republic



TOSSING 2 COINS, 100 times		COIN 2	
		H	T
COIN 1	H	HH 25	H T 25
	T	TH 25	T T 25

Imagine yourself a banker. To save money, you devised an ingenious scheme of monitoring the vigilance of your bank's night watchman. At the opposite ends of the building, there are 2 light switches. Every hour during his 10-hour shift, the guard must approach one switch and flip a coin. If it's Heads, he is to turn the switch on, if it's Tails, he is to turn it off. He then must approach the second switch and repeat the same procedure. If both switches are on, the light is on. If either one is off, or if both are off, the light is off. You have installed a special machine that tells you, for every hour, whether the light has been on or off. Four months and 1000 hours later, you examine the lighting record to determine whether the guard should receive a raise or be fired. You observe that during that time, the light has been on 570 hours and off 430 hours.

Q13. What are your theoretical expectations for the number of hours the lights should have been on and off? Why? Should the guard be promoted or sacked?

2 SWITCHES must be on to produce light: Ratio light / dark: 3:1		Switch II	
		ON	OFF
switch I	ON	light	dark
	OFF	dark	dark

Mendel's Observations

Worked with peas

True-breeding varieties, e.g., tall and short

The Cross

Tall Peas X Short Peas (Parents)

What kind of offspring will they have?

Surprising answer: children: ALL TALL

Mendel then crossed these new tall plants (the offspring of the Tall X Short cross) to themselves or to each other. Did you guess the outcome?

Grandchildren: 787 tall / 277 short.

So,

- Short: reappeared (so it must have still been there, somehow, out of sight!)
- Tall / Short ratio: 2.84 to 1 (approximately 3 to 1).

Similar observations with other characters, e.g., smooth vs. wrinkled seeds

Smooth X Wrinkled

P generation: Smooth vs. Wrinkled seeds

F1 generation: All smooth

F2 gen: 3 smooth for every 1 wrinkled

Mendel gave 2 lectures on the subject. In the first he described the results you have just seen. In the second, he explained them.

Take home Q was: Imagine you found yourself in Mendel's shoes. What would you tell your audience?

Let's review Mendel's work now a bit more formally

Gregor Mendel

- Was the first person to analyze patterns of inheritance.
- Deduced the fundamental principles of genetics.

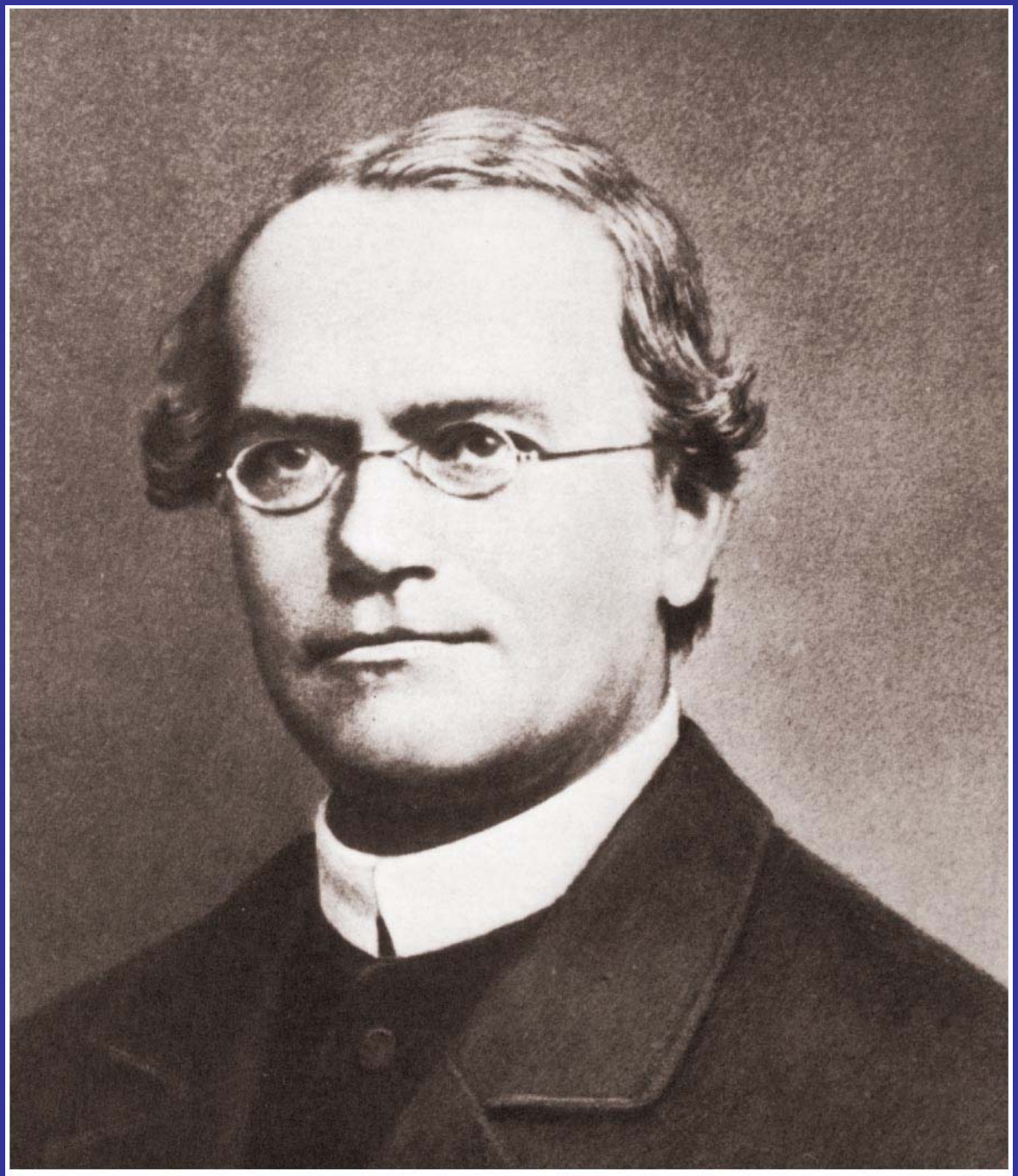


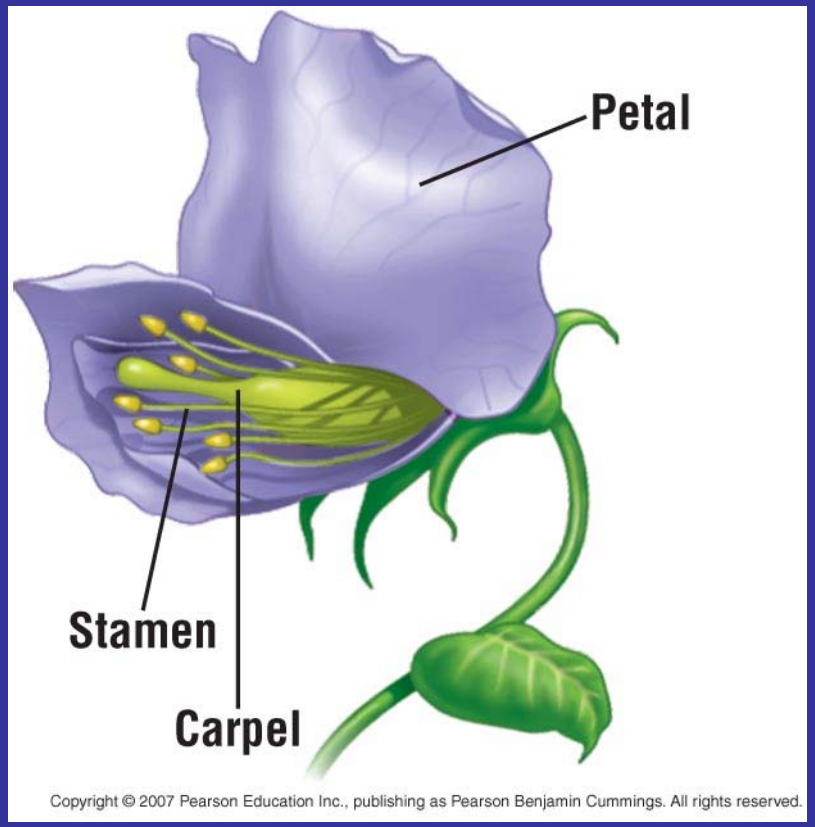
Figure 9.2

In an Abbey Garden

Mendel studied garden peas because these plants are

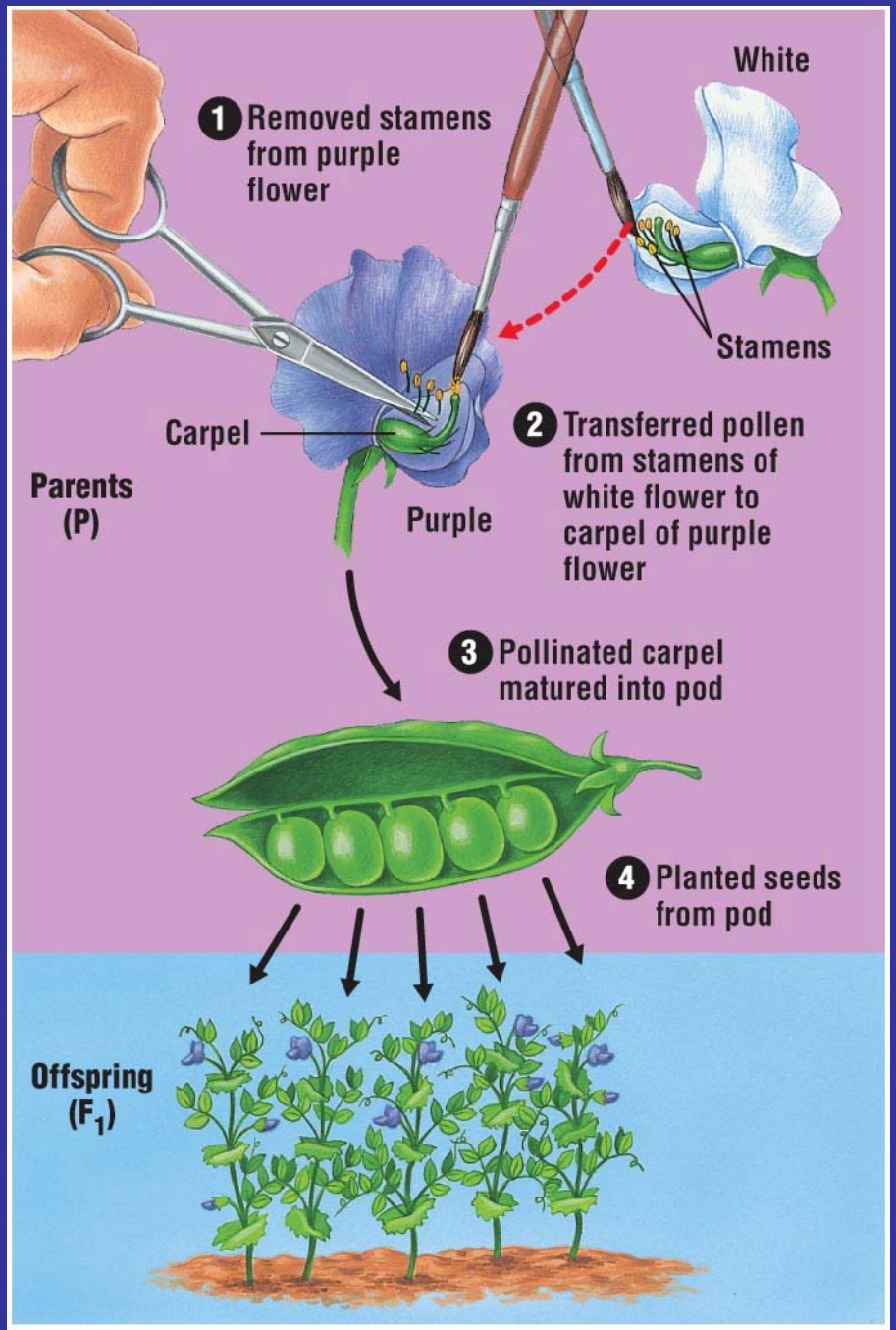
- Easily grown
- available from seed sellers in many true-breeding varieties
- readily manipulated.
- Capable of self-fertilization

Structure of a Pea Flower



Mendel carried out cross-fertilization: Both pollen and egg come from the same parent.

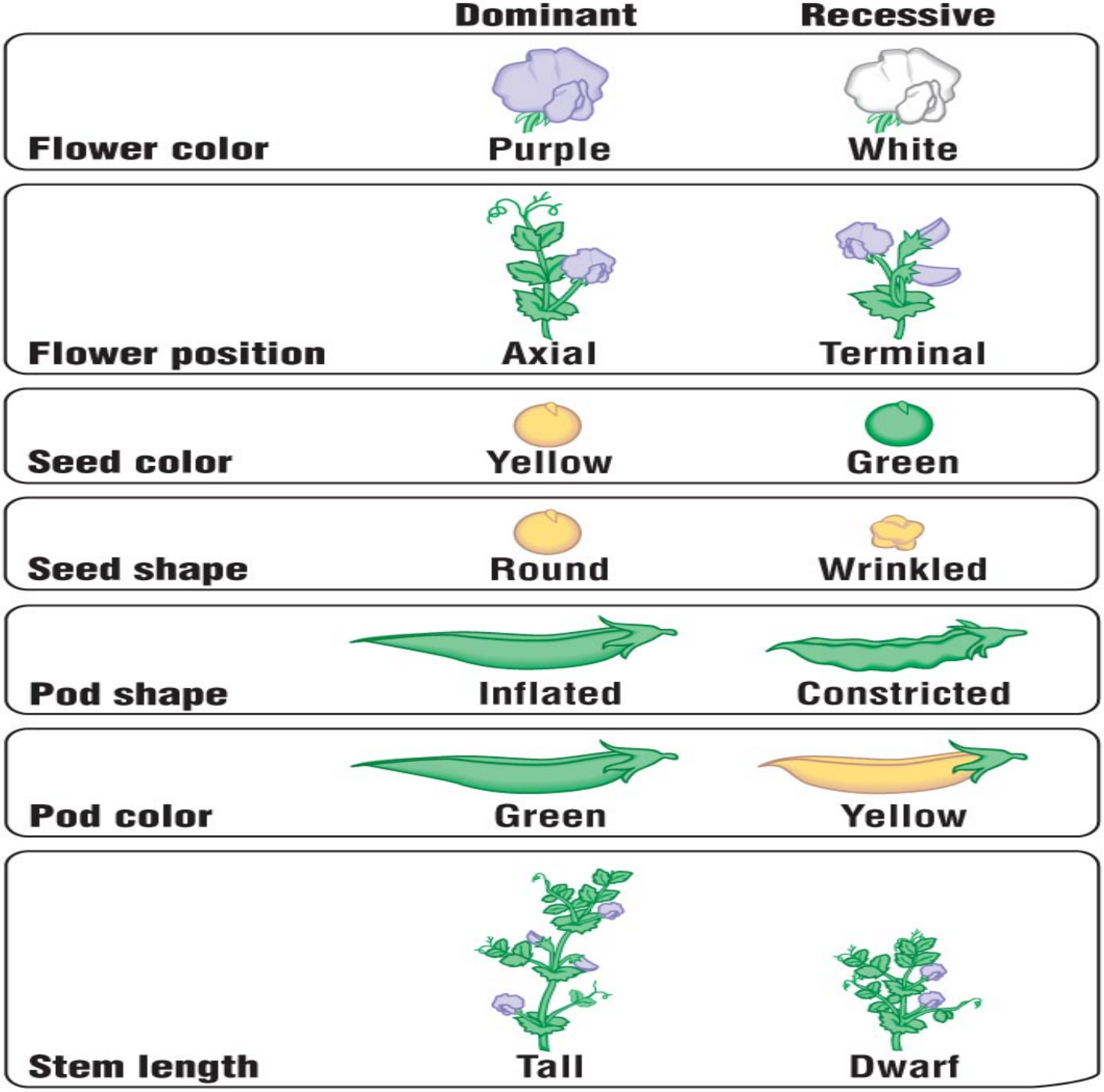
Mendel's technique for cross-fertilizing peas



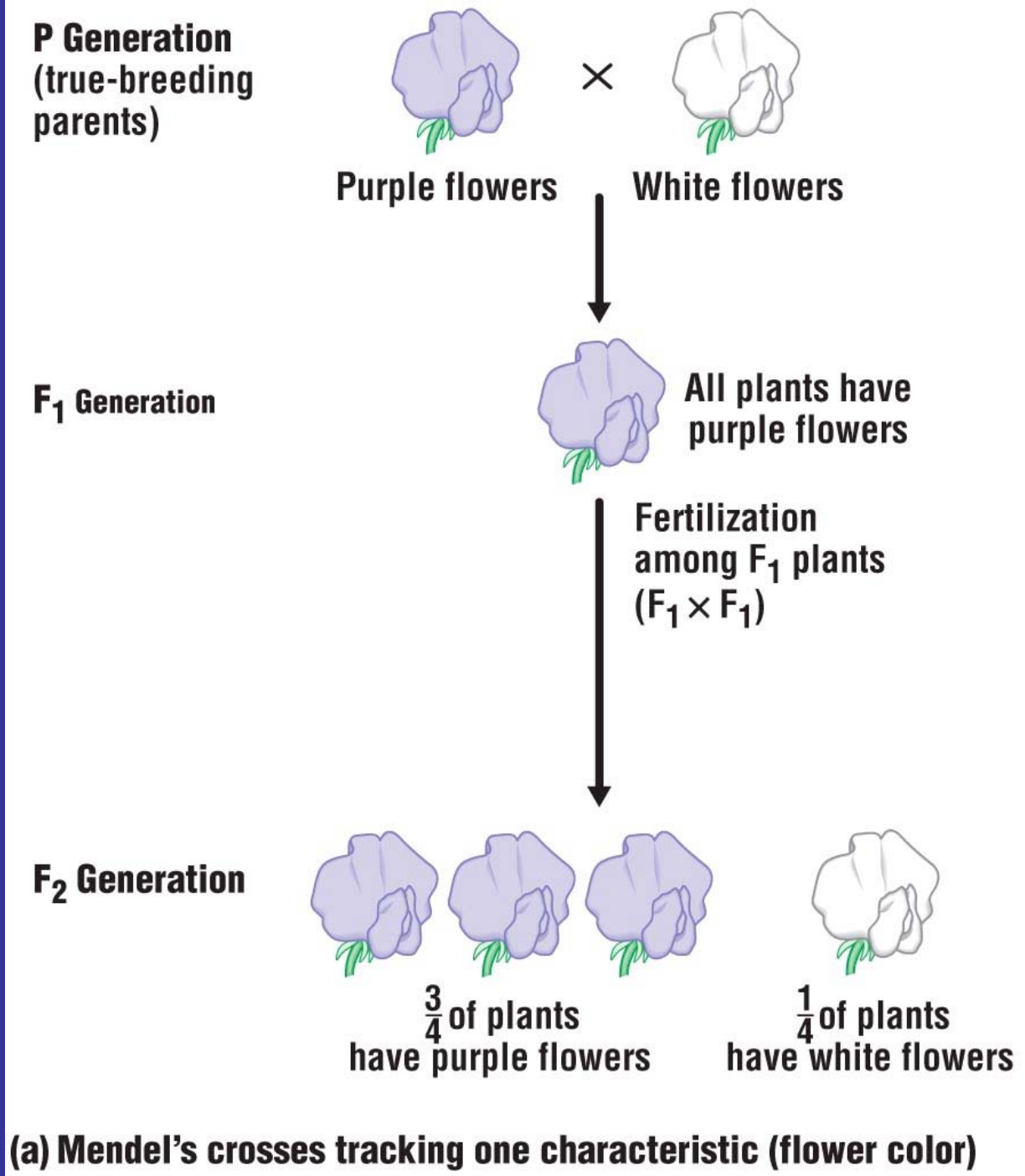
Mendel's Law of Segregation

Mendel studied 7 traits of peas

Mendel studied 7 traits of peas



A cross of 2 true-breeding varieties.



(a) Mendel's crosses tracking one characteristic (flower color)

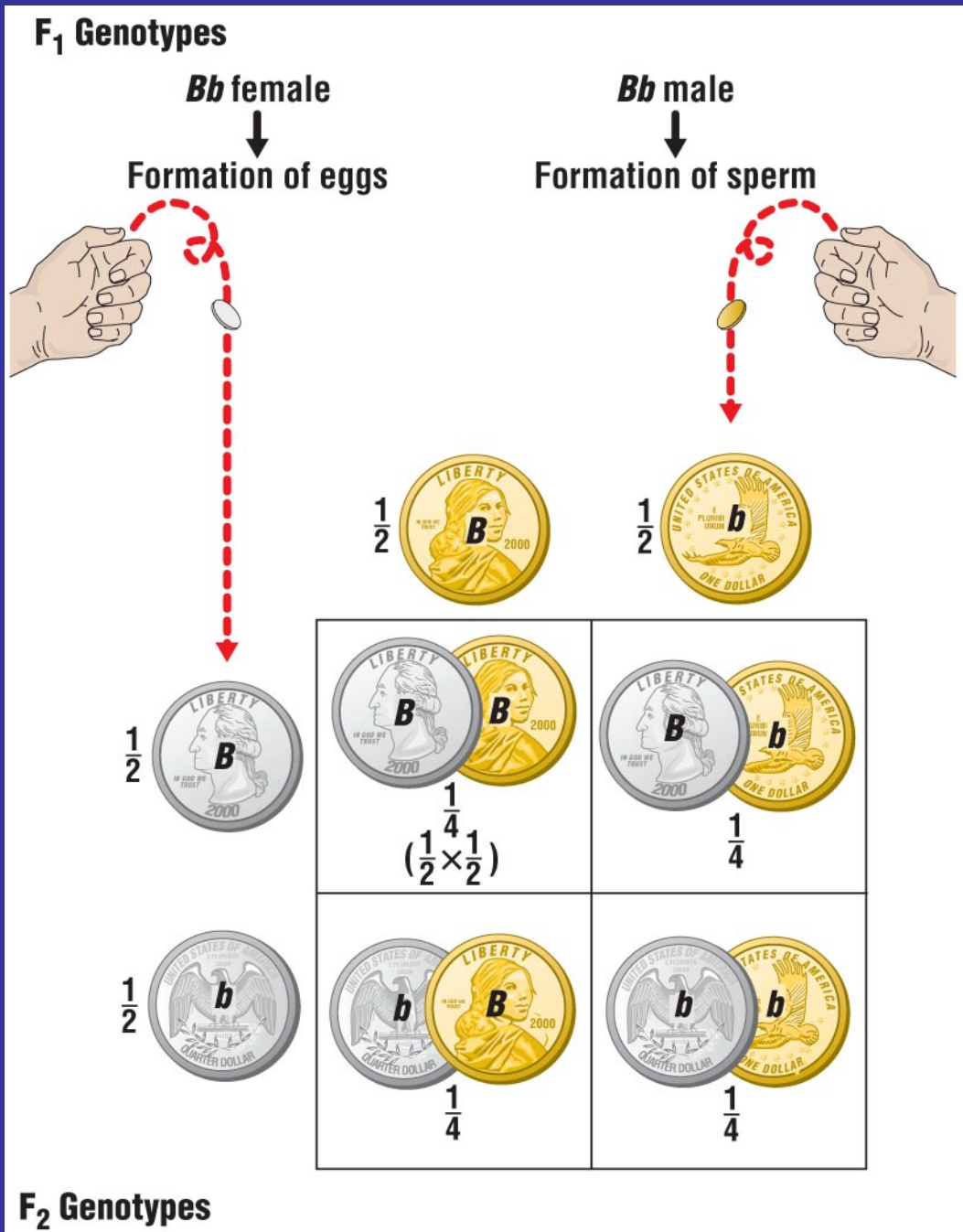
Recall first our security guard, his two switches, and the 3:1 ratio:		Switch II	
		ON	OFF
switch I	ON	light	dark
	OFF	dark	dark

What could possibly account for the 3:1 ratio in peas? We can assume that any given trait (e.g., seed color) is determined by two factors. We call such factors genes. Each one of a pair of genes is called an allele. Let us call the allele that determines purple color of flowers P, and the one that determines white color, p.

– Mendel's law of segregation

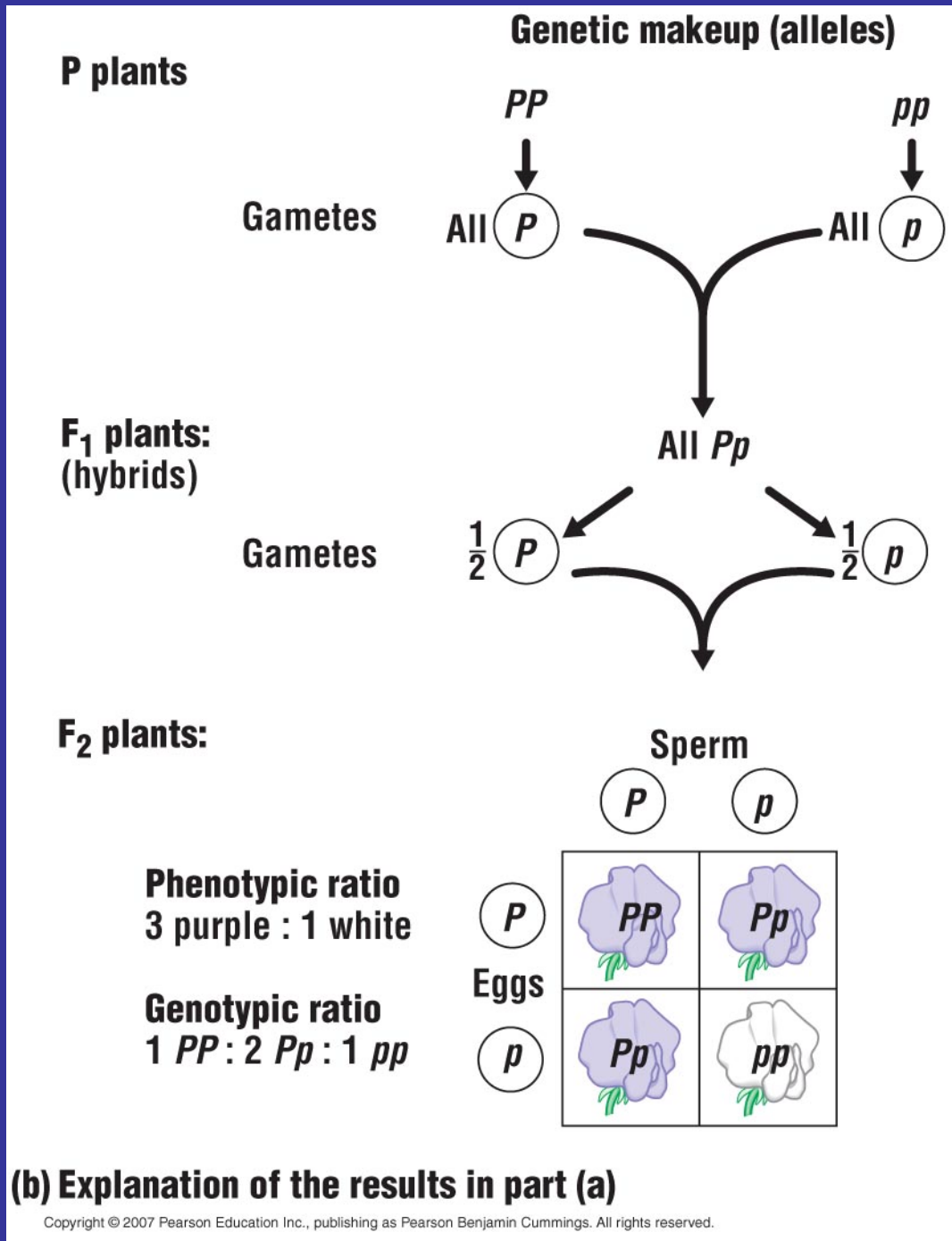
The two alleles of a gene segregate (separate) from each other during the production of pollen (or sperm) and eggs.

Let us remind ourselves one more time of coin tossing



Why 3:1 ratio?

- Gamete: eggs or pollen (or sperm)
- Alleles: alternative factors of same gene
- Phenotype: How an organism looks like
- Genotype: The actual alleles (genes)



– The chart above assumes that:

- There are alternative forms of genes, called alleles.
- Gametes (=sex cells, pollen or eggs) carry only one allele for each inherited characteristic.
- For each characteristic, an organism inherits two alleles, one from each parent.
- Alleles can be dominant or recessive.

– Phenotype
  - An organism's physical traits, e.g., purple flowers
– Genotype
  - An organism's genetic makeup, e.g., PP or Pp in the F1 generation

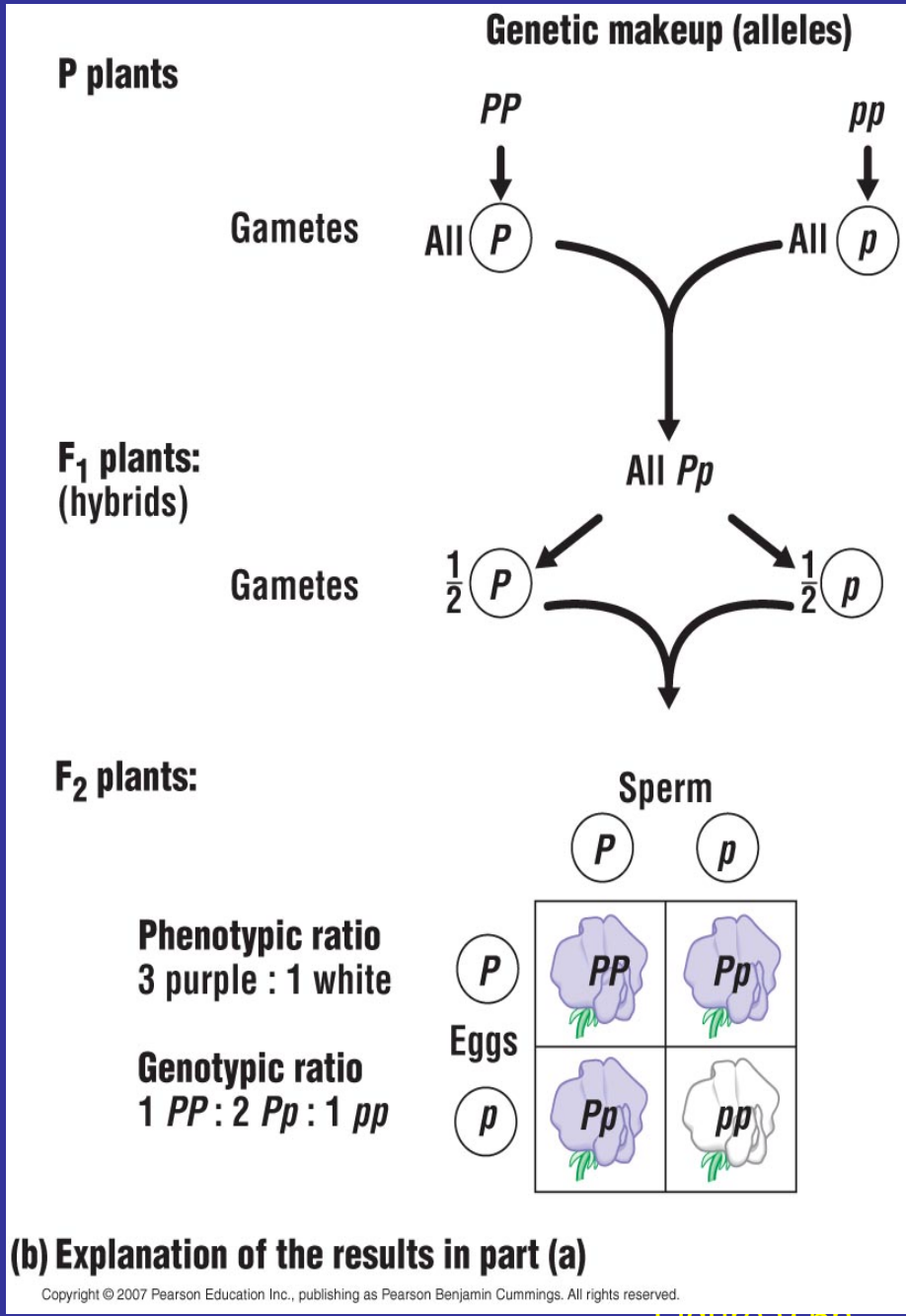


Figure 9.6b

–Homozygous

The organism has identical 2 genes for a trait

–Heterozygous

The organism has different 2 genes for a trait

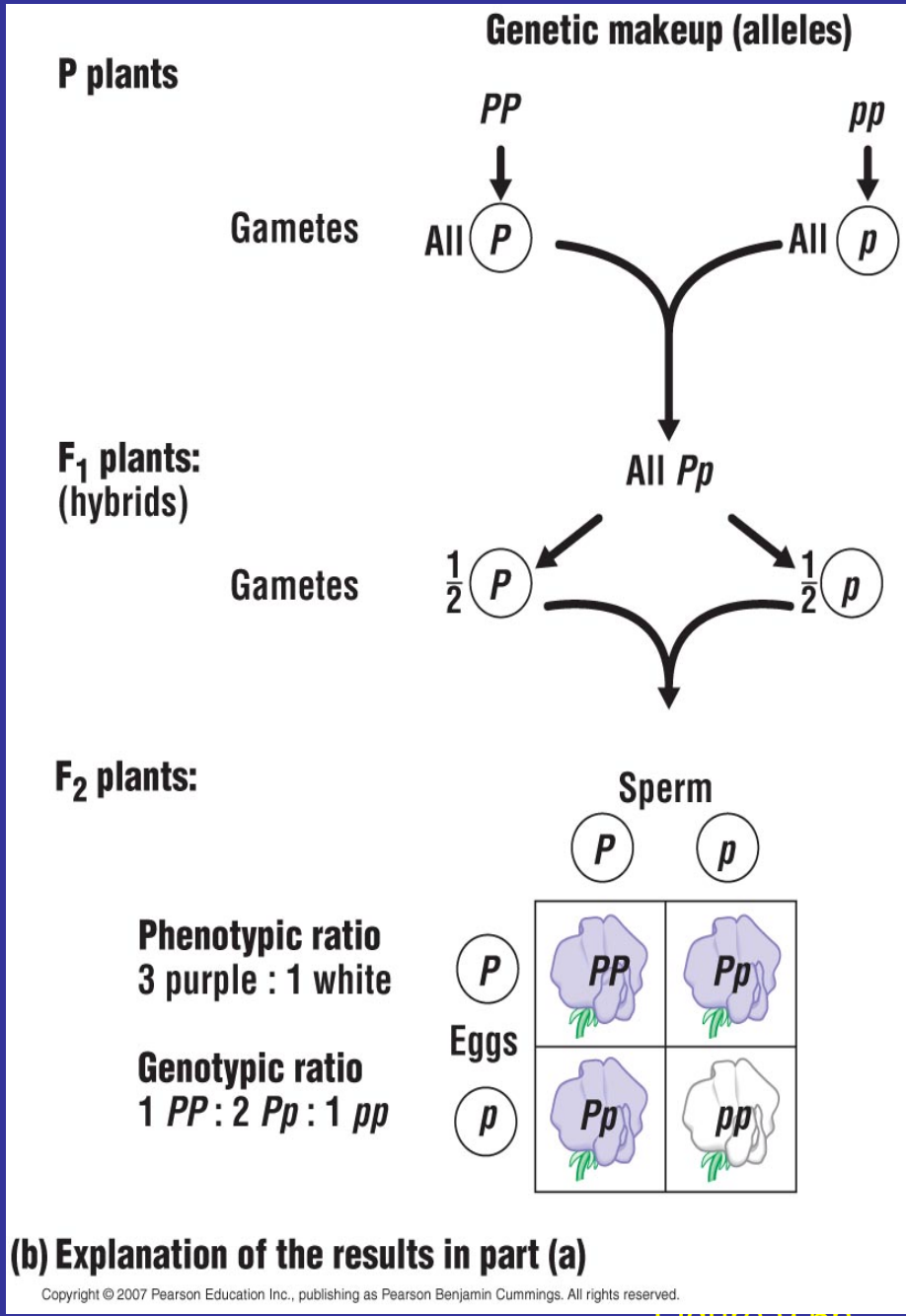


Figure 9.6b

– Dominant gene

The gene that dominates the appearance, e.g, determines purple color

– Recessive gene

The gene that is not shown, e.g., white color

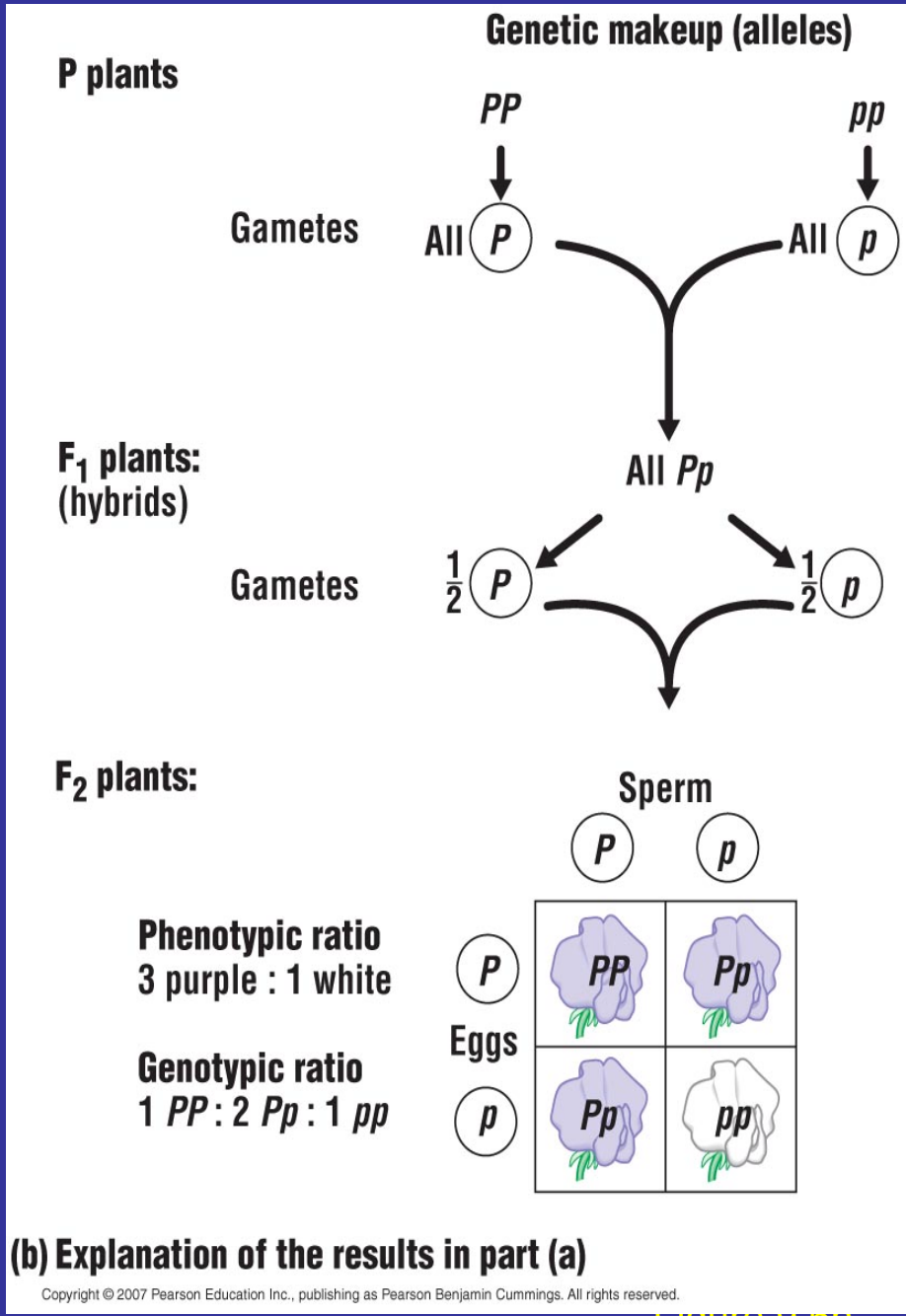


Figure 9.6b

Using a Testcross to Determine an Unknown Genotype

A testcross is a mating between an individual of unknown genotype and a homozygous recessive individual, to test the genotype of the individual with the unknown genotype.

A Question

What is the genotype of peas with white seeds?

.

Answer: There are 3 possible genotypes: PP, Pp, pp. The first 2 appear purple, so, if a pea has white flowers, it must be pp.

What is the genotype of an individual with purple flowers?

Answer: It can be either:

–PP

OR

–Pp

A Testcross		pea plant with purple flowers: PP or Pp	
		if PP	If Pp
pea plant with white flowers: (pp)	p	Pp (all purple) So: Genotype was PP	½ P p ½ Purple ½ white So: genotype was Pp

Your text gives the example of coat colors in Labrador retrievers:

BB=black lab

Bb=black lab

bb=chocolate lab

--Which genotypes are homozygous?

--Which are heterozygous?

--Which is the recessive allele?

--Which is the dominant allele?

Homozygous? Answer: BB, bb

Heterozygous:Bb

Recessive gene? b

Dominant: B

Testcross:

×

Genotypes *B_* *bb*

Two possibilities for the black dog:

BB or ***Bb***

Gametes ***B*** ***B*** ***b***

b ***Bb***

b ***Bb*** ***bb***

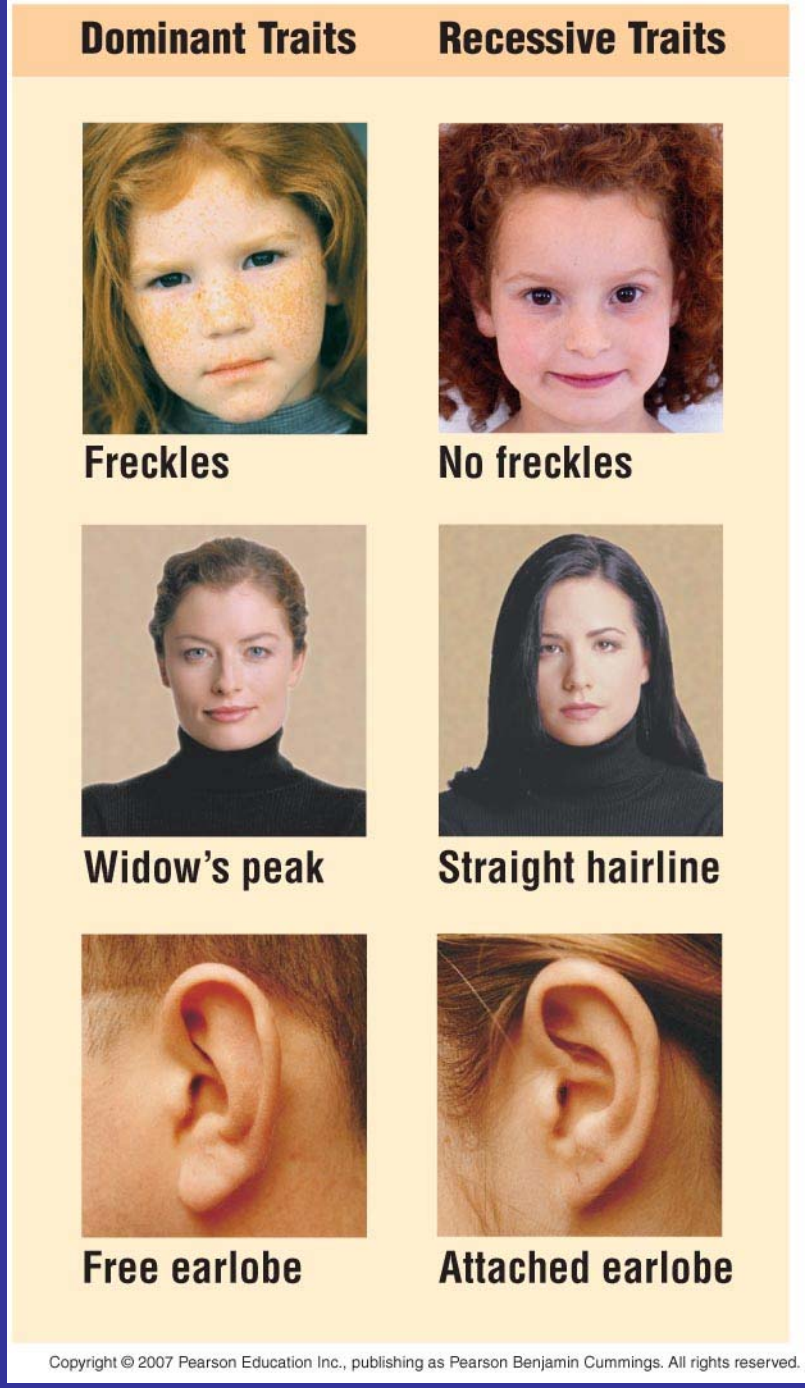
Offspring **All black** **1 black : 1 chocolate**

A man with an attached earlobe married a woman with an attached earlobe. Their son John has a free earlobe. What will a genetic counselor say about that?

It's anyone's guess whose son John is! F=free earlobe f=attached earlobe		mom (ff)	
		f	f
Dad (ff)	f	ff (attached)	ff(attached)
	f	ff(attached)	ff(attached)

Conclusion: John is not their biological child

A man with an attached earlobe is married to a woman with a free earlobe. They have 28 children. Can we determine her genotype?



We certainly can!

If all 28 children have attached earlobes then she is:

FF

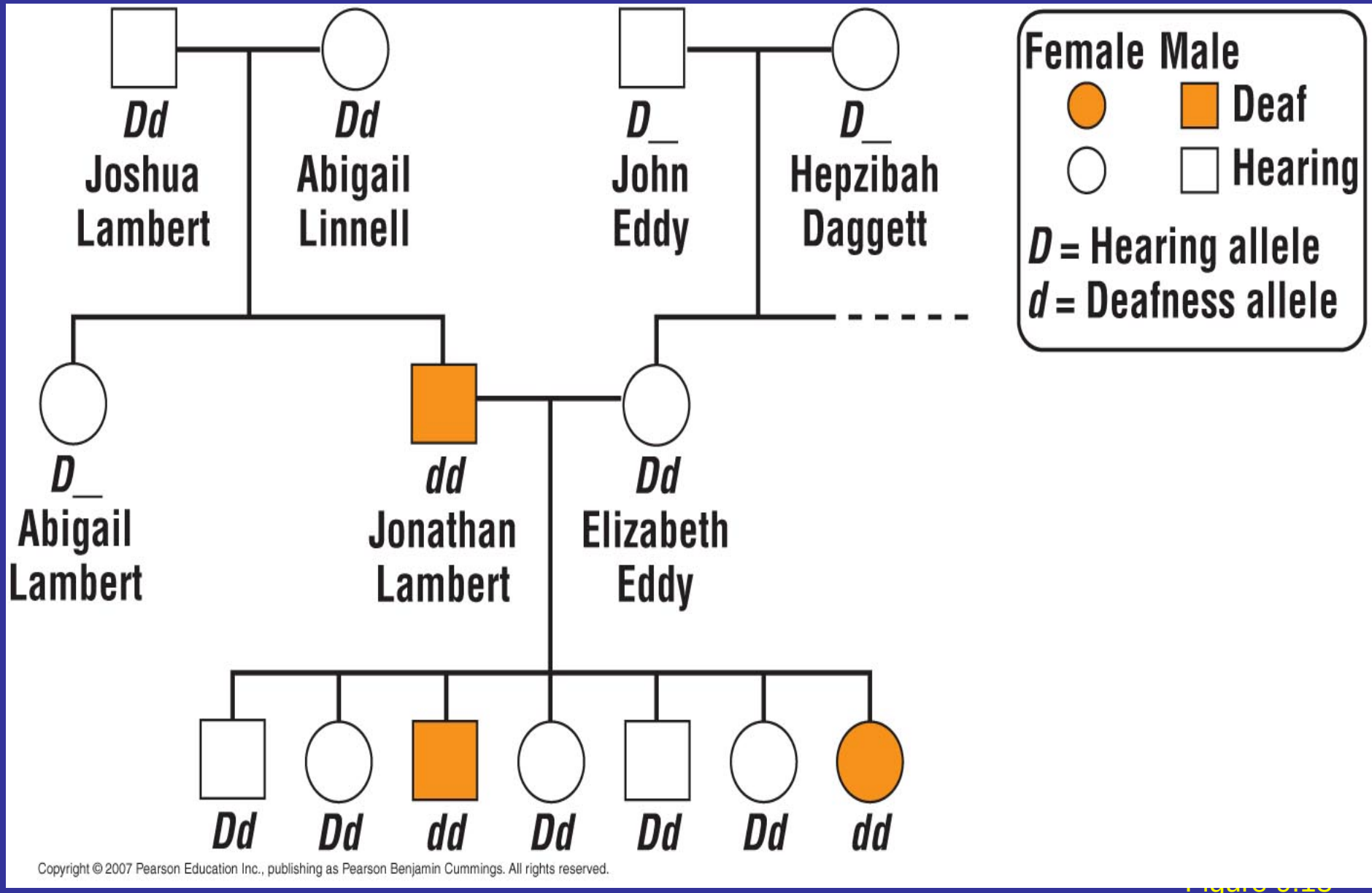
If about ½ the children have free earlobes, then she is:

Ff

Family Pedigrees

Mendel's principles apply to the inheritance of many human traits.

– A family pedigree
  - Shows the history of a trait in a family.
  - Allows geneticists to analyze human traits.



Some Human Disorders are Controlled by a Single Gene

- Many human traits
  - Show simple inheritance patterns
  - Are controlled by a single pair of gene

Table 9.1 Some Autosomal Disorders in Humans

Disorder	Major Symptoms	Incidence
Recessive Disorders		
Albinism	Lack of pigment in skin, hair, and eyes	$\frac{1}{22,000}$
Cystic fibrosis	Excess mucus in lungs, digestive tract, liver; increased susceptibility to infections; death in early childhood unless treated	$\frac{1}{1,800}$ European-Americ
Galactosemia	Accumulation of galactose in tissues; mental retardation; eye and liver damage	$\frac{1}{100,000}$
Phenylketonuria (PKU)	Accumulation of phenylalanine in blood; lack of normal skin pigment; mental retardation unless treated	$\frac{1}{10,000}$ in U.S. and Europ
Sickle-cell disease (homozygous)	Sickled red blood cells; damage to many tissues	$\frac{1}{500}$ African-Americans
Tay Sachs disease	Lipid accumulation in brain cells; mental deficiency; blindness; death in childhood	$\frac{1}{3,500}$ Ashkenazi Jews
Dominant Disorders		
Achondroplasia	Dwarfism	$\frac{1}{25,000}$
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	$\frac{1}{25,000}$
Hypercholesterolemia	Excess cholesterol in blood; heart disease	$\frac{1}{500}$

Recessive Disorders

- Most human genetic disorders are recessive.
  - Individuals can be carriers of these diseases but not show any sign of ill health
  - They manifest the disorder only when they have two recessive alleles

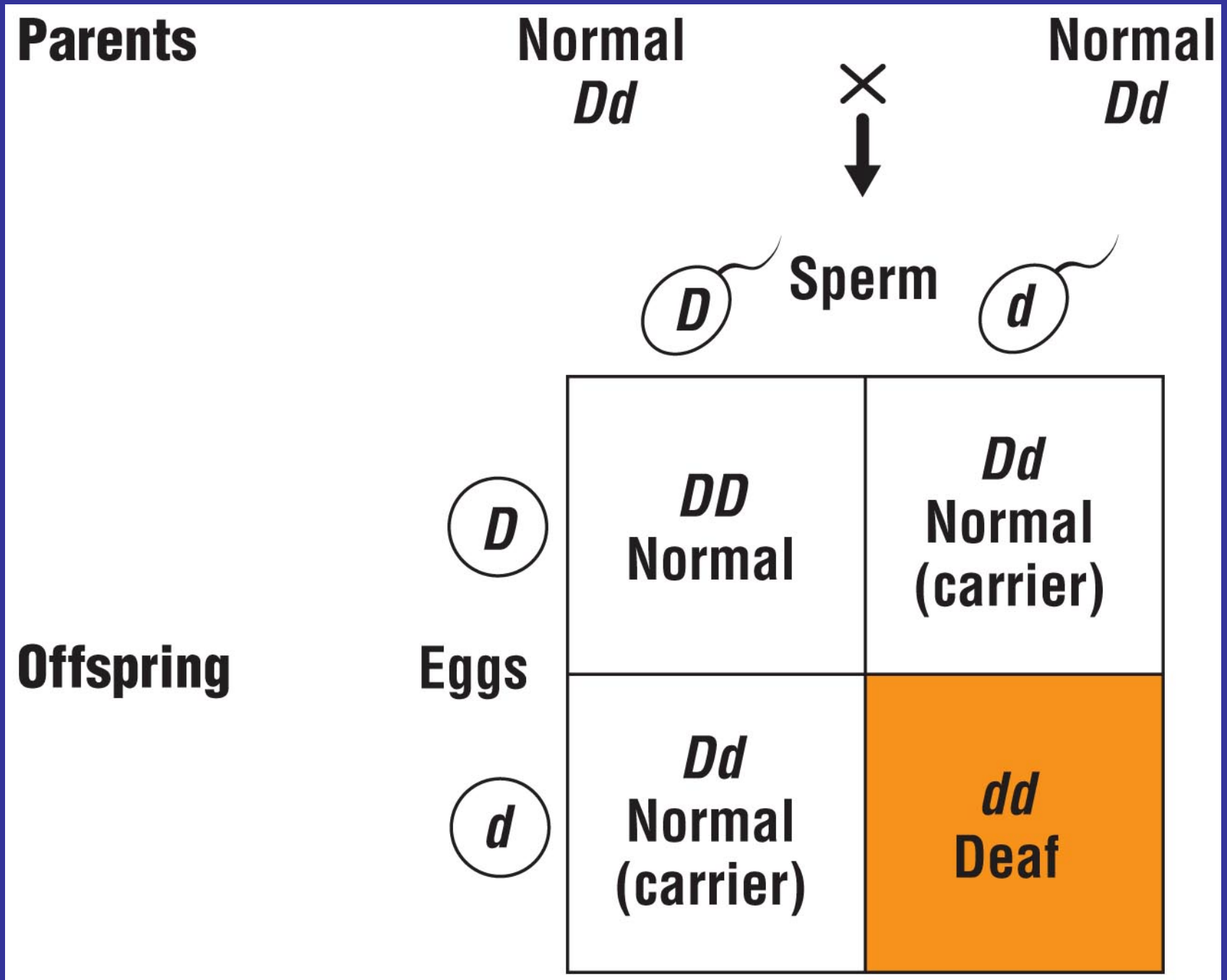


Figure 9.14

Dominant Disorders

- Some human genetic disorders are dominant. You just need one gene to have it. (AA has it; Aa has it; only aa doesn't)
  - Achondroplasia is a form of dwarfism.

Dr. Michael C. Ain has achondroplasia, a form of dwarfism. Head and torso, normal; limbs, short

Figure 9.13

Variations On Mendel's Laws

Some patterns of genetic inheritance do not conform to Mendel's original generalizations. Here, just one example:

Incomplete Dominance in Plants and People

- In incomplete dominance, F_1 hybrids have an appearance that is in-between the phenotypes of the two parents.

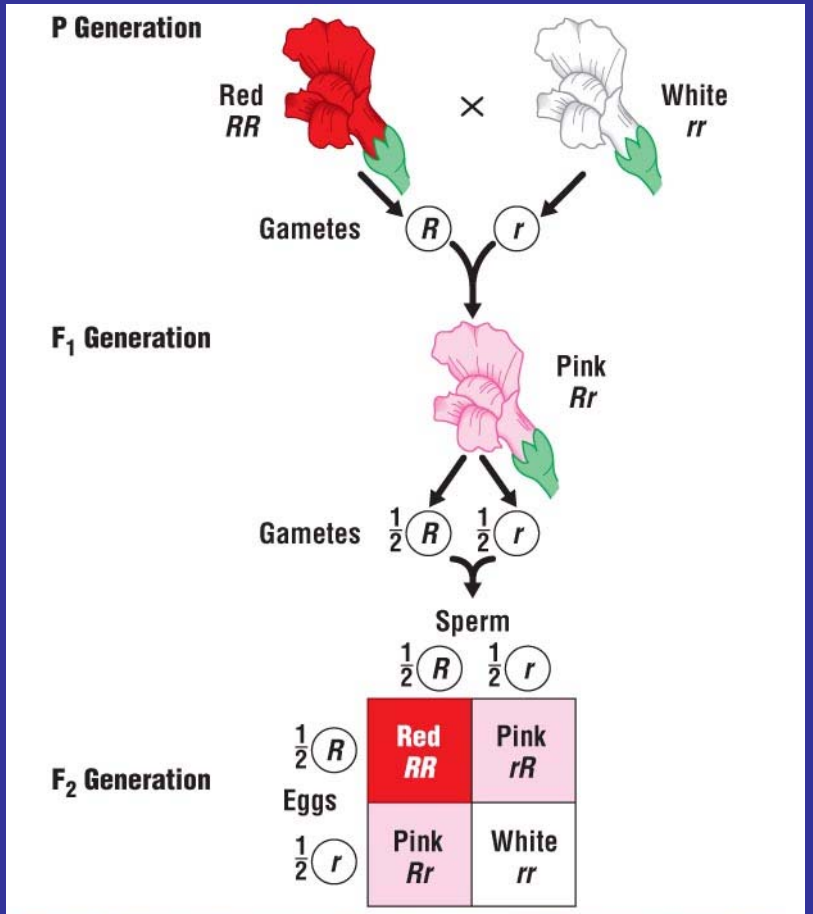


Figure 9.16

Biology And Society: A Few Applications

Genetic counselling: Albinism:

Colorless skin, hair, eyes, seen only in individuals with 2 recessive genes, aa. AA, Aa are normal. So, what advice will you give when both parents are albinos?

Answer: If we cross aa to aa, we can only get aa, or an albino. The couple has a 100% chance of having an albino child

Genetic counseling:

Albinism

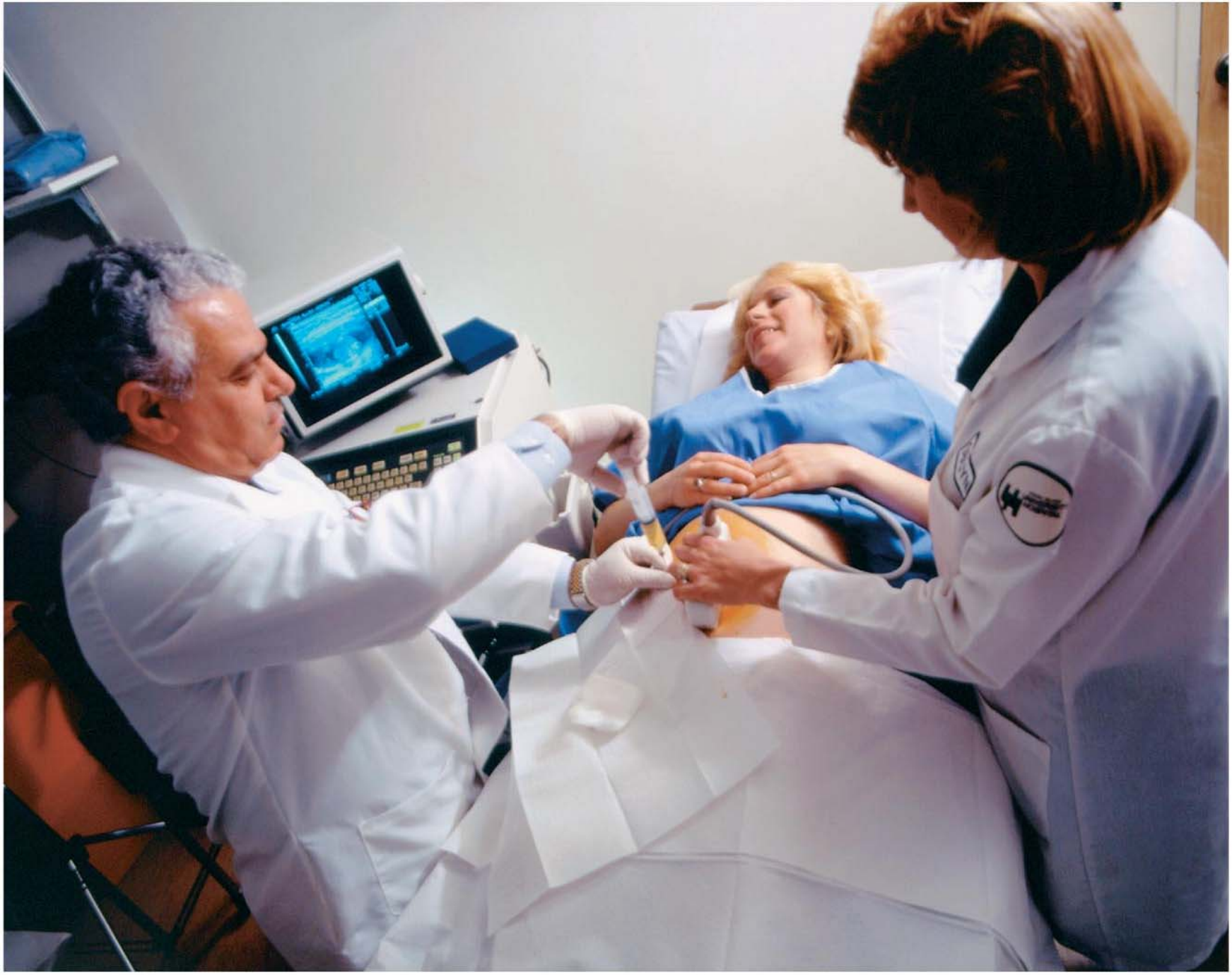
What if a normal couple comes in, and they have one albino child? Each parent must be Aa, and the chance of the next child being an albino is?

Answer: Aa X Aa: ¼ AA (normal); ½ Aa (normal but carriers); ¼ aa, albino

Biology And Society: Testing Before Birth

Genetic testing:

- Allows expectant parents to test their unborn child.
- Includes amniocentesis (needle in tummy) and CVS (tube in vagina)
- Both are associated with risks



Critical Thinking in Action: Applying Genetics and Common Sense to Genealogy

"Before you brag about your family tree, better do some pruning!"

Sensible Genealogists?

Mary, Queen of Scots, 1542-1587

Donna Marie Nissani, 1957-?

Now, Donna and I have a long-standing argument:

She has been told that she is a direct descendant of Mary, Queen of Scots, and is proud of it. I, on the other hand, have maintained over the last 22 years, that her bragging is misguided, for a least 4 reasons:

- **Paternity:** Shakespeare ("It is a wise father that knows his own child," --10% paternity fraud every generation?)
- **Truthfulness**
- **Dilution:** 400 years
- **Morality:** Who gets to be a queen in human history?

First, there is the problem of ascertaining paternity over so many generations, as the following suggests:

A Redneck Love Poem

Susie Lee done fell in love,
She planned to marry Joe.
She was so happy 'bout it all,
She told her Pappy so.

Pappy told her,

"Susie Gal,you'll have to find another.
I'd just as soon yo' maw don't know,
But Joe is yo' half-brother."

- So Susie put aside her Joe,
  And planned to marry Will.
  But, after telling Pappy this,
  He said, "There's trouble still.
- You cain't marry Will, my gal,
  And please don't tell yo' mother,
  But Will and Joe and several mo'
  I know is yo' half-brother."
- But Mama knew and said "My Child,
  Just do what makes yo' happy.
  Marry Will or marry Joe,
  ... you ain't no kin to Pappy.“

It takes just one case of mistaken paternity along the line of 16 generations (400 years / 25) to invalidate Donna's claim. If we assume, based on some research, that her chances of being her father's child are 90%, and so on for every generation of a male ancestor, the chances that she is her grandfather's grandchild are .9X.9=.81. For 8 generations (males only, we can be sure of female ancestors), $0.9^8 = 0.43$. Just owing to paternity doubts, Donna's chances are less than half of having Mary, Queen of Scots, as an ancestor

Next, we have the problem of someone lying during the last 300 years. Again, it will just take one liar, out of roughly 16 ancestors, to invalidate the claim. What are the chances of this? Hard to say, but probably again, overall, 50% or more.

You next have the problem of relatedness, which is what is being claimed here. Forgetting our other problems, Donna has 2 parents, 4 grandparents, and, by the 16th generation, she might have had as many as 32,768 ancestors. Even allowing for overlaps, only some 1/10,000 of her genes are traceable to Mary, Queen of Scots. You and I might be more closely related to each other than she is to Mary! Another way of looking at it, to single Mary out of a crowd of 10,000 contemporaries, all related to Donna, seems a bit silly!

My final argument is historical and moral. What kind of a person was Mary? Most likely, she, like other powerful people, was a psychopath, or close to it. That is how, in case you didn't notice, you get to the top in this world—killing, stealing, cheating, backstabbing, looking out for #1. I for one, hope and pray that I am not a descendant of even one powerful person with a bad soul and a bad stomach!

To be on the safe side, I showed this diatribe to Donna. She read it and actually found some typos. I then asked her: Have you changed your mind?

What do you think her answer was?

She was of course NOT convinced at all. This is one of the greatest weakness we all have: We are just about unable to change our mind about anything. To find out more about this aspect of human nature, click here.

Genetics and History

Is human aggression determined by genes? Long ago, did the USA commit the worst genocide in history because of that? Have we killed about 3 million Iraqis from 1990 to 2007 because of our genes too? Chimpanzees for example engage in warfare and infanticide. And, if extreme violence is in our genes, is there any hope for us? (Chimps fight with their hands, while we fight with napalm, H-bombs, or genetically-engineered bacteria!)

Hemophilia

Or take a look at this monarch. Power-hungry Victoria was genocidal, all right. As well, she had, another interesting trait—she was a carrier of the gene for hemophilia, a serious bleeding disorder

Now, European royalty preferred marrying their own (conniving, murder, and exploitation, not genetics, were their preferred subjects!). “English” royalty, for instance, are mostly German. During World War I, the Russian, English, and British tyrants were cousins!

Anyway, the Russian cousin’s son received Victoria’s gene for hemophilia, and the rest, as they say, is history!

Review Problems, Lectures 1-5

Nature of Science:

Problem: The light on my computer screen is out.

- Can you come up with a hypothesis (educated guess) for my troubles?
- Can you propose a test prediction of that hypothesis?
- If the test fails, can you come up with another hypothesis / prediction / test?

Childbed Fever

1. What was Ignaz Semmelweis' problem?
2. Name at least 3 of his hypotheses?
3. Each of these hypotheses led to which tests?
4. Which hypothesis was not falsified by actual, real-world, scientific tests?

Nature of Science (cont)

1. The Semmelweis washing hands discovery was a forerunner of which great medical / biological theory?
2. Was Semmelweis's washing hands theory immediately embraced by his Medical colleagues? Was their criminally heartless conduct typical of science, or an exception?

The Cell

Please describe and explain at least 3 cases of technical / scientific breakthroughs which enabled us to see or hear things we could not see or hear before

To enhance its power, microscopy must enhance:

Magnification or Magnification?

- Resolution or Resolution?
- Contrast or Contrast

What is the key assertion of Cell Theory?

Among other schemes, biologists often use 2 to classify living organisms. What are these 2 schemes?

- An organism can have one cell or many
- An organism can be a prokaryote or a eukaryote

Scientific Notation

1. In terms of whole meters (m), the average professional basket player is almost _____ m tall.
2. One m has how many ml?
3. How many m in a km?
4. What does it mean, $1X10^{3}$ m? $1X10^{-3}$ m?

Please express in plain English

$1.1X10^{10}$

$2.5X10^{12}$

$3.1X10^{-6}$

There are roughly, $1X10^{8}$ households in the USA. When all expenses are considered, the conquest of Iraq (it is not a “war”) will cost the USA, in the long run, at least $\$3X10^{12}$ (to find out more, click here). How much, in plain English, will the ongoing conquest of Iraq cost your household?

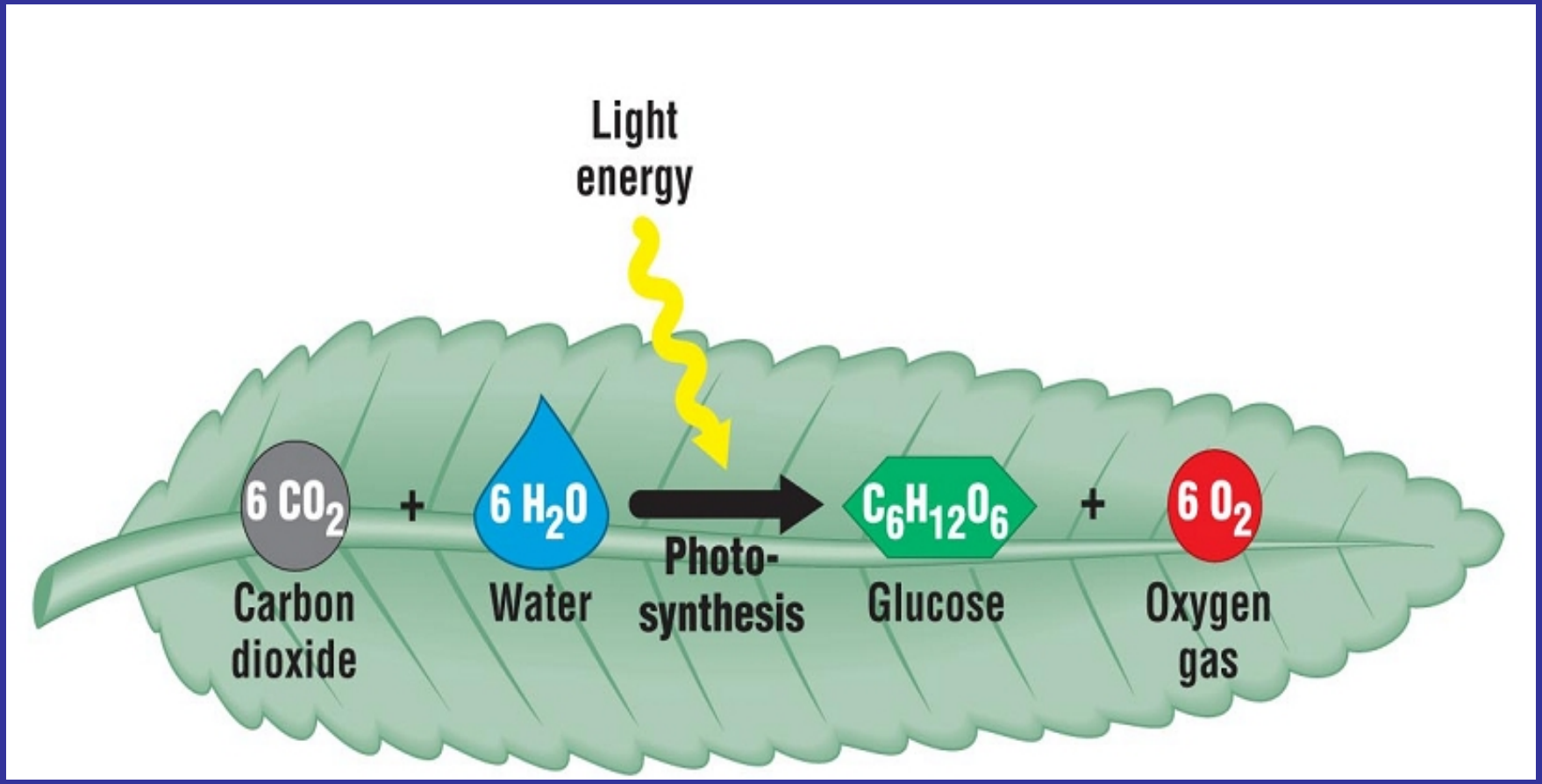
.

The average bacterial cell is about $1X10^{-5}$ m, while the average animal cell is about $1X10^{-4}$ m.

- Which cells are bigger, prokaryotes or eukaryotes?
- By how much?

The sizes of a cell of an elephant, a human, or a rat are roughly equal. So why are elephants bigger than rats?

Photosynthesis: What's the basic reaction?



Why is photosynthesis so VERY important to us?

Among other things:

- Food
- Oxygen
- Less heat (greenhouse effect requires CO_2)

What was Engelmann’s question?
How did he go about answering it?
What was the answer?

- What was Engelmann's hypothesis?
- His prediction?
- His test?

1. Why is Earth warmer than the moon?
2. Which part of Earth is responsible for this greater coziness?
3. How does this part do it?

What's wrong with this argument?

A lot of people out there complain about the "greenhouse effect" and the presence of "too much carbon dioxide." What these fools do not realize, is that carbon dioxide is essential to life. Without it, earth would be too cold, and there would be no photosynthesis. So, the claim of "global warming" is pure hogwash.

Which facts raise the possibility that climate change might be real?

What do Mendel's and Semmelweis' scientific careers tell us about organized science?

So, if organized science in America (or any other country) was in a position to make money from a terribly risky invention, would it do it?

Let us assume (I'm making this number up), that there are $4X10^8$ families on earth with 2 children each. In plain English, how many of these families have:

- Two boys?
- Two girls?
- A girl and a boy?

What is the ratio of families with either 1 or 2 girls to families with only boys?

Among other colors, the coat color of Labrador retrievers can be black or chocolate. Black is determined by a dominant allele (gene) and chocolate by a recessive allele.

1. What is the phenotype of either dog?
2. What is the genotype?
3. What will happen when a chocolate bitch mates with a black dog?

Now, I know nothing about the lineage of the chocolate bitch, but I know for sure that the black dog comes from a line that always produces black labs. If I cross these 2, what kinds of puppies will they have?

What will happen if I cross their children one to the other (not recommended)?

The gene for freckles is dominant. A freckled Scottish lass married a non-freckled Scottish lad.

1. What's the lady's genotype?
2. What the lady's genotype if her daughter has no freckles?

A friend of yours brags that she is a descendant of the great physicist, Isaac Newton (1643-1727). Which 4 arguments could you use to get her off her high horse?

Listen: I'm My Own Grandpa