Biology 1305 – Modern Concepts in Bioscience – Campbell Textbook – Week 10

Hey hey guys! I hope you all are doing well. Welcome back to another resource! We are now approaching the end of the semester, and this is where things can get extremely hectic if you let it. Remember, a lot of professors are trying their best to be done with their course material before we go online, so be prepared for a lot of material fast with some successive exams. The end of the semester is always tough, so don't let all your hard work go to waste in this. Finish strong!!

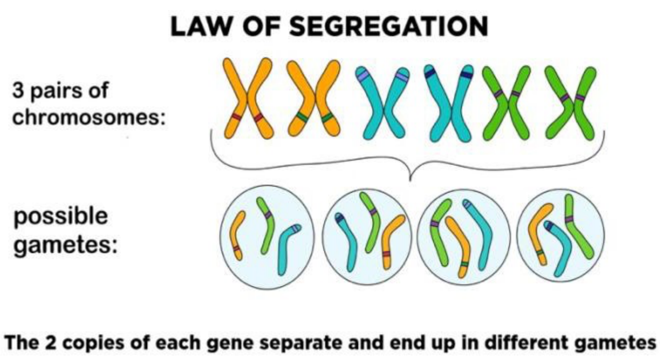
Remember that the Tutoring Center offers free individual and group tutoring for this class. Our Group Tutoring sessions will be every Thursday from 5:00-6:00 PM CST. You can reserve a spot at https://baylor.edu/tutoring. I hope you sign up!:)

This week's resource will discuss: mendelian genetics, independent assortment, probability laws

Basis of Mendelian Genetics

We all have heard of Gregor Mendel, the man who discovered the basic principles of heredity by breeding his garden peas, and while the information may be old and familiar to you, the concepts he discovered are essential to our understanding of heredity (and you need to know them for Genetics 2306 too)

By performing his experiments, Mendel discovered two important laws about heredity:



The Law of Segregation: which states that alleles on a gene separate from each other to end up in different gametes during gamete formation. Which makes sense as we all know that in Meiosis, sister chromatids split up to end in different gametes correct? **Do you remember what step of Meiosis is this?**

Additionally, Mendel discovered the **Law of Independent Assortment**, which tells us the details regarding allelic separation. The law states that allele separation occurs independently of any other pair of alleles, which is HUGE! Now we know that allelic separation does not depend on another allele separation, therefore we do not need to consider other alleles to calculate probabilities of inheritance!

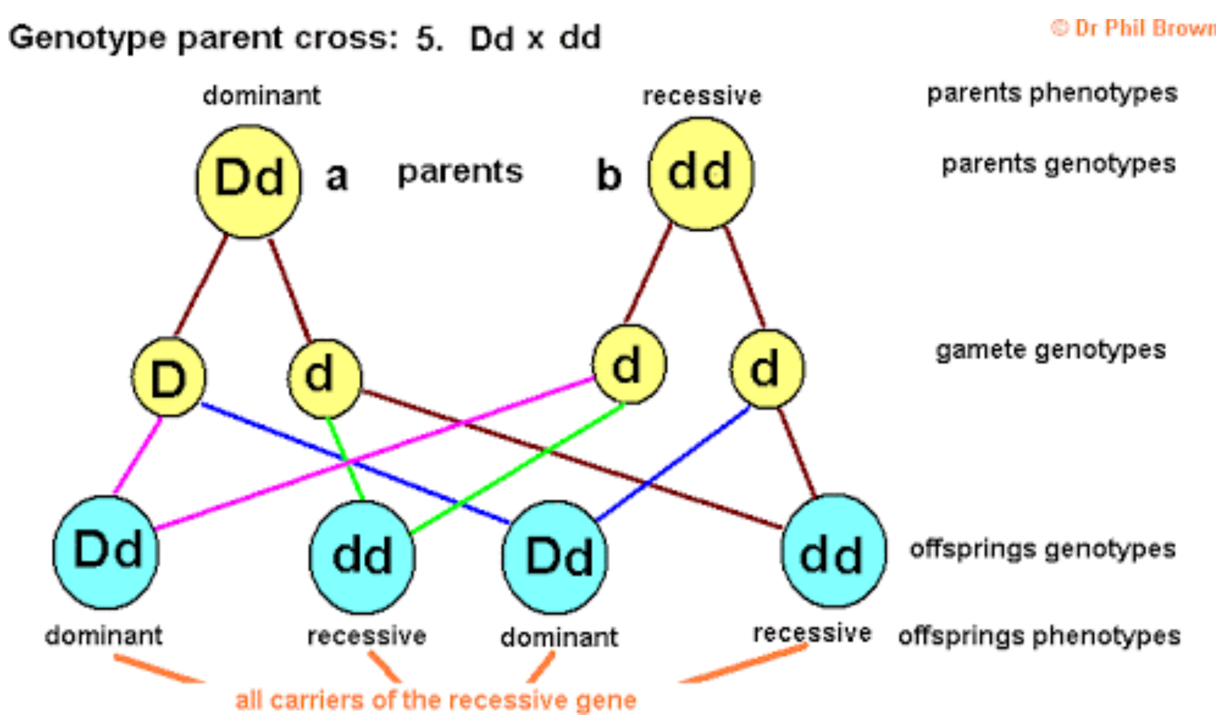
So how does this come into play?
Let's look at a very generic example:

If a flower has a specific genotype Hh, we would say that it is **heterozygous for this trait.** Now, what type of gametes would this flower form?

Well, we would use our basic laws of mendelian genetics to figure this out. The Law of Segregation says alleles are going to separate into different gametes, meaning the H allele and h allele are going to end up in **different gametes!**

To calculate the probability of getting a gamete with H, we use the Law of Independent Assortment to remind ourselves that the allele separation is independent in other alleles, and we would find that we have a ½ chance of getting a H gamete and ½ chance of getting a h gamete!

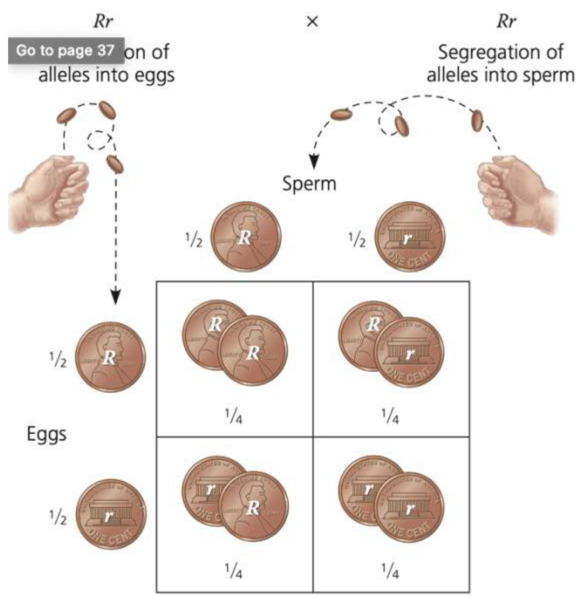
Here is another example of crossing that should help you visualize these laws of mendelian genetics. Notice how **each allele ends up in a different gamete and those probabilities are independent of one another!**



Source: Doc Brown's Chemistry

Probability and Mendel Laws

Let's have a mom with a genotype Rr and a dad with a genotype Rr (this color coding is important for this concept) mate to produce an F1 offpsring. What would be the expected genotype and phenotype ratios?



Now, many of you guys would do a Punnett Square to solve this, but you will soon learn that this process can get very complicated the more alleles we get, so it is better to rely on probability to figure this problem out. This is a Punnett Square of the situation (using coins I know bear with me here).

Now what about using probability?

Let's calculate the probability of having an offspring with RR:

We have a cross of Rr x Rr

We know the probability of getting a big R from dad is ½
We know the probability of getting a big R from mom is ½

Both of these events have to happen at the **SAME TIME** to get us a zygote with RR, therefore we can think of this as two independent events that HAVE to occur in a specific combination. Similar to flipping two coins at the same time to try and get heads for both. Due to this, we use the **multiplication rule and multiply the two probabilities together**. Remember, to get a RR zygote we need a R from mom **AND** a R from dad. The probability is ¼

But what about Rr?

We have a cross of Rr x Rr

IMPORTANT: We have two possible ways of getting this specific genotype, we can get Rr or Rr. Each parent can donate either allele, so we have to do some more thinking to solve for this probability, and we need another rule.
R dad and r from mom

Big R from Dad and little r from mom would have a probability of ¼

Now let's calculate the probability of getting r from dad and R from mom

Little r from Dad and Big R from mom would have a probability of ¼

So we have two probabilities, ¼ for both scenarios, so what do we do? We need to calculate the probability of getting Rr **OR** Rr. Even though they are the same genotype, because the alleles can come from different sources ,we need to consider each scenario its own event. Additionally, we need to remember these events are **mutually exclusive of one another**, **meaning if I get R from mom and r from dad, there is no way I can get R from dad and little r from mom.** This is similar if you wanted to roll a 2 **OR** 3 on a 6-sided die, those are mutually exclusive events as when you roll a 2, you cannot have any other number.

Based off the fact that these events are mutually exclusive, we ADD the two probabilities together: ¼ + ¼ = ½

While you may be reading this and think that a Punnett square could have done it faster, when you get to more complex questions, you will find yourself pressed for time. For example, if I have a cross of PpYyRr * Ppyyrr, and I was asked to find the fraction of offspring with at least two recessive traits, I would probably cry if I had to make the punnett square for this.

Using probability though, it is a very simple problem. Let's list off every genotype that can fufill this requirement, and solve for them! I will start the first one and you can finish the problem. (answer at the end, but try it yourself first)

ppyyRr: (probability of pp ¼) x (probability of yy ¼) x (probability of Rr is ½) = 1/16

ppYyrr

Ppyyrr

PPyyrr

ppyyrr

Degrees of Dominance
Epistasis

Answer to Probability Question:

ppyyRr	$1/4$ (probability of *pp*) $\times 1/2$ (*yy*) $\times 1/2$ (*Rr*)	$= 1/16$
ppYyrr	$1/4 \times 1/2 \times 1/2$	$= 1/16$
Ppyyrr	$1/2 \times 1/2 \times 1/2$	$= 2/16$
PPyyrr	$1/4 \times 1/2 \times 1/2$	$= 1/16$
ppyyrr	$1/4 \times 1/2 \times 1/2$	$= 1/16$
Chance of *at least two* recessive traits		$= 6/16$ or $3/8$