Name:_____

Wonder Genetics

Part 1: Traits

A **trait** is a quality or characteristic of an individual. Example: brown hair or blue eyes.

1. Another example of a trait is:_____

2. Where do people get their traits from?_____

   _____

3. What do you notice about traits of people within one family?_____

   _____

   _____

Read the following excerpt from *Wonder*, on pages 103-104. This passage is from the perspective of Via.

> Both sides of Dad's family were Jews from Russia and Poland. Poppa's grandparents fled the pogroms and ended up in NYC at the turn of the century. Tata's parents fled the Nazis and ended up in Argentina in the forties. Poppa and Tata met at a dance on the Lower East Side while she was in town visiting a cousin. They got married, moved to Bayside, and had Dad and Uncle Ben.
>
> Mom's side of the family is from Brazil. Except for her mother, my beautiful Grans, and her dad, Agosto, who died before I was born, the rest of Mom's family—all her glamorous aunts, uncles, and cousins—still live in Alto Leblon, a ritzy suburb south of Rio. Grans and Agosto moved to Boston in the early sixties, and had Mom and Aunt Kate, who's married to Uncle Porter.
>
> Mom and Dad met at Brown University and have been together ever since. Isabel and Nate: like two peas in a pod. They moved to New York right after college, had me a few years later, then moved to a brick townhouse in North River Heights, the hippie-stroller capital of upper Manhattan, when I was about a year old.
>
> Not one person in the exotic mix of my family gene pool has ever shown any obvious signs of having what August has. I've pored over grainy sepia pictures of long-dead relatives in babushkas; black-and-white snapshots of distant cousins in crisp white linen suits, soldiers in uniform, ladies with beehive hairdos; Polaroids of bell-bottomed teenagers and long-haired hippies, and not once have I been able to detect even the slightest trace of August's face in their faces. Not a one. But after August was born, my parents underwent genetic counseling. They were told that August had

what seemed to be a "previously unknown type of mandibulofacial dysostosis caused by an autosomal recessive mutation in the TCOF1 gene, which is located on chromosome 5, complicated by a hemifacial microsomia characteristic of OAV spectrum." Sometimes these mutations occur during pregnancy. Sometimes they're inherited from one parent carrying the dominant gene. Sometimes they're caused by the interaction of many genes, possibly in combination with environmental factors. This is called multifactorial inheritance.

4. Is August's facial deformity a trait? Yes No

5. Where did August get his facial deformity from? _____

_____

6. What does this mean about the genetic material his parents have?_____

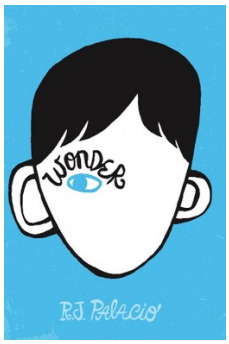
_____

_____

7. Peoples' genetic material is stored in sections of DNA called **genes**. Each gene will determine how a specific trait (ex: face freckles) is displayed. Each gene carries two pieces of genetic material. These pieces are known as **alleles**. Alleles code for the different version of the trait (ex: freckles or no freckles). Draw a picture of a gene and label the alleles in the gene.

8. We will be exploring the gene that is responsible for August's facial deformity (trait = facial deformity). What are the versions of the trait (the alleles) and what will you use to represent these versions?_____

_____



9. If August has the deformity, draw what his, his parent's, and Via's genes could be.

Parents: (Generation 1)	Isabel Shows Deformity:_____ Gene:	Nate Shows Deformity:_____ Gene:
Children: (Generation 2)	August Shows Deformity:_____ Gene:	Via Shows Deformity:_____ Gene:

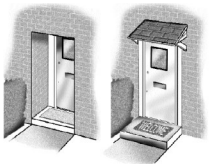
10. Who did August get his alleles for his deformity from? _____

_____

11. In general, how are alleles inherited?_____

_____

12. A recess is a small space created by building part of the wall farther back from the rest. Circle the door that is recessed.



13. Why do you think August's facial deformity is called a recessive trait?

_____

_____

_____

_____

Read the following excerpt from *Wonder*, on page 104. This passage is from the perspective of Via.

> In August's case, the doctors were able to identify one of the "single nucleotide deletion mutations" that made war on his face. The weird thing is, though you'd never know it from looking at them: both my parents carry that mutant gene. And I carry it, too.

14. Do your answers in question 9 agree with this statement from the book? _____

_____

_____

_____

_____

Part 2: Probability of Traits

As a class we want to understand what causes changes in the frequency of inherited traits and be able to predict the frequency in which the condition will occur.

15. What are the key parts of describing how traits are passed down?

- _____
- _____
- _____

16. What do we know about the genes that each member of August's family carries that are associated with his facial deformity?

	Allele 1	Allele 2	Shows the Trait		Allele 1	Allele 2	Shows the Trait
Isabel				August			
Nate				Via			

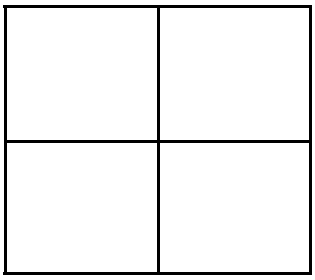
17. If Isabel and Nate were to have another baby, what is the probability that they would have a baby with a facial deformity?

Possible Combinations of Alleles in Children

Possibility	Allele From Isabel	Allele From Nate	Child Will Show the Trait
1			
2			
3			
4			
5			

This would cause the child to have a _____ chance of having the **deformity** and a _____ chance of **not having the deformity**.

18. Draw another way to show the possible combinations of alleles in their children.



This would cause the child to have a _____ chance of having the **deformity** and a _____ chance of **not having the deformity**.

Do these results agree with question 16?

Yes No

This is known as a _____

Part 3: Testing Our Model

In partners, you will simulate possible children that Isabel and Nate could have. Decide who will be Isabel and Nate.

Isabel:_____ Nate:_____

Each bag represents a gene. Inside the bag are the two alleles the parent possesses. Reach into your bag and pull out one allele while your partner does the same. These alleles will form the gene of your child. Determine if the gene would cause the child to show the facial deformity or not. Do this process 12 times and fill in the table for each child.

19. Our Model (use question 18 to fill out the table):

Appearance	Fraction	Equivalent Fraction (out of 12)	Number of Children we Predict we will get in the Simulation
Deformity			
No Deformity			

20. Data Table

Child	Allele From Isabel	Allele From Nate	Child Shows the Trait
1			
2			
3			
4			
5			
6			

Child	Allele From Isabel	Allele From Nate	Child Shows the Trait
7			
8			
9			
10			
11			
12			

21. Fill in the table with your simulation results.

Appearance	Number of Children from Simulation	Fraction (out of 12)	Number of Children we Predicted Simulation Would Give (from question 18)
Deformity			
No Deformity			

22. Does your data exactly match the predicted data? Yes No

23. Fractions that other groups recorded:

Fraction Having	Fraction Not

24. Does everyone's data exactly match the predicted data? Yes No

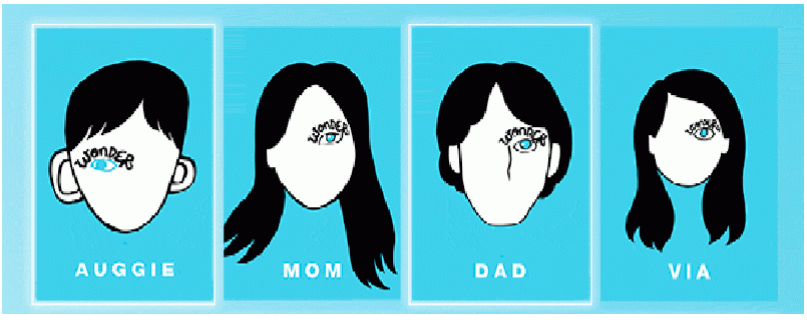
25. Is the data that the class gathered close to the predicted data? Yes No

26. Does the model have limitations and when is it most accurate?_____

_____

_____

_____



Part 4: Via's and August's Possible Children

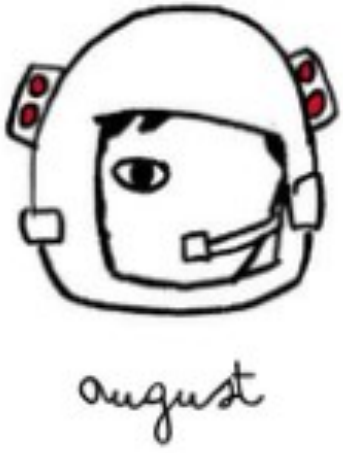
Read this excerpt from *Wonder*, on pages 105-106. This passage is from the perspective of Via. In the passage, box information about the partners that is discussed and underline information about the probabilities that is discussed.

If I have children, there's a one-in-two chance that I will pass on the defective gene to them. That doesn't mean they'll look like August, but they'll carry the gene that got double-dosed in August and helped make him the way he is. If I marry someone who has the same defective gene, there's a one-in-two chance that our kids will carry the gene and look totally normal, a one- in-four chance that our kids will not carry the gene at all, and a one-in-four chance that our kids will look like August.

If August has children with someone who doesn't have a trace of the gene, there's a 100 percent probability that their kids will inherit the gene, but a zero percent chance that their kids will have a double dose of it, like August. Which means they'll carry the gene no matter what, but they could look totally normal. If he marries someone who has the gene, their kids will have the same odds as my kids.

This only explains the part of August that's explainable. There's that other part of his genetic makeup that's not inherited but just incredibly bad luck.

Countless doctors have drawn little tic-tac-toe grids for my parents over the years to try to explain the genetic lottery to them. Geneticists use these Punnett squares to determine inheritance, recessive and dominant genes, probabilities and chance. But for all they know, there's more they don't know. They can try to forecast the odds, but they can't guarantee them. They use terms like "germline mosaicism," "chromosome rearrangement," or "delayed mutation" to explain why their science is not an exact science. I actually like how doctors talk. I like the sound of science. I like how words you don't understand explain things you can't understand. There are countless people under words like "germline mosaicism," "chromosome rearrangement," or "delayed mutation." Countless babies who'll never be born, like mine.



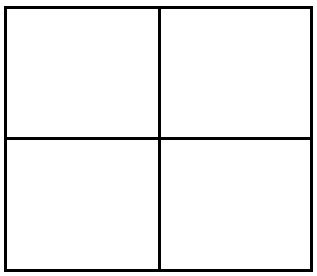
Use the boxes below to create Punnett squares showing the different possibilities for Via's and August's children. If we know the alleles that Via and August carry as well as the alleles their partners carry, we can make predictions of their children's chances of having the facial deformity, being a carrier, or not carrying the allele at all. These chances can also be converted into percentages.

27.Via's future children if she is **a carrier**.

What would be the effect caused by Via having a child with a partner who is **not a carrier**?

Partner

Via



_____chance of **having the deformity**, which equates to_____%.

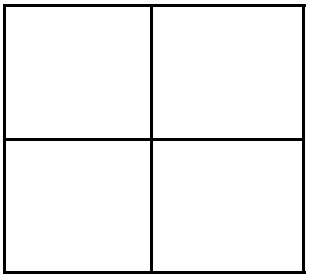
_____ chance of not having the deformity but **being a carrier**, which equates to_____%.

_____ chance of not having the deformity and **not being a carrier**, which equates to_____%.

What would be the effect caused by Via having a child with a partner who is **a carrier**?

Partner

Via



_____chance of **having the deformity**, which equates to_____%.

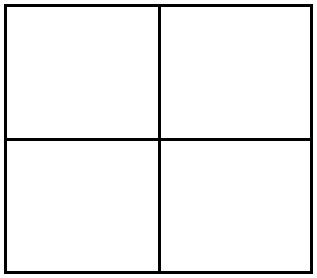
_____ chance of not having the deformity but **being a carrier**, which equates to_____%.

_____ chance of not having the deformity and **not being a carrier**, which equates to_____%.

What would be the effect caused by Via having a child with a partner who **shows the deformity**?

Partner

Via



_____chance of **having the deformity**, which equates to_____%.

_____ chance of not having the deformity but **being a carrier**, which equates to_____%.

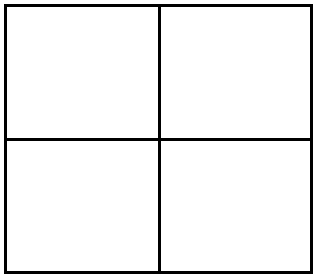
_____ chance of not having the deformity and **not being a carrier**, which equates to_____%.

28.Via's future children if she is **not a carrier**.

What would be the effect caused by Via having a child with a partner who is **not a carrier**?

Partner

Via



_____chance of **having the deformity**, which equates to_____%.

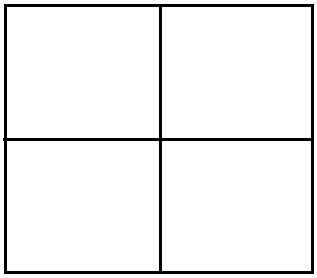
_____ chance of not having the deformity but **being a carrier**, which equates to_____%.

_____ chance of not having the deformity and **not being a carrier**, which equates to_____%.

What would be the effect caused by Via having a child with a partner who is **a carrier**?

Partner

Via



_____chance of **having the deformity**, which equates to_____%.

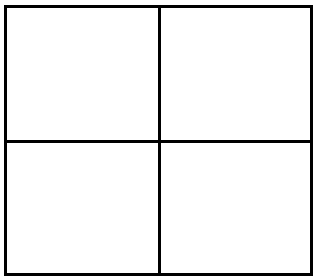
_____ chance of not having the deformity but **being a carrier**, which equates to_____%.

_____ chance of not having the deformity and **not being a carrier**, which equates to_____%.

What would be the effect caused by Via having a child with a partner who **shows the deformity**?

Partner

Via



_____chance of **having the deformity**, which equates to_____%.

_____ chance of not having the deformity but **being a carrier**, which equates to_____%.

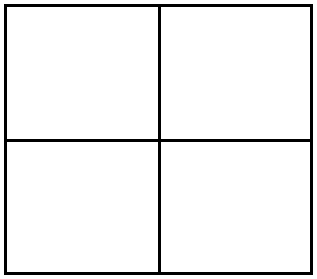
_____ chance of not having the deformity and **not being a carrier**, which equates to_____%.

29.August's future children.

What would be the effect caused by August having a child with a partner who is **not a carrier**?

Partner

August



_____chance of **having the deformity**, which equates to_____%.

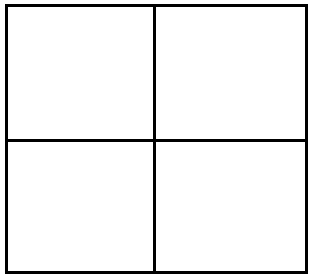
_____ chance of not having the deformity but **being a carrier**, which equates to_____%.

_____ chance of not having the deformity and **not being a carrier**, which equates to_____%.

What would be the effect caused by August having a child with a partner who is **a carrier**?

Partner

August



_____chance of **having the deformity**, which equates to_____%.

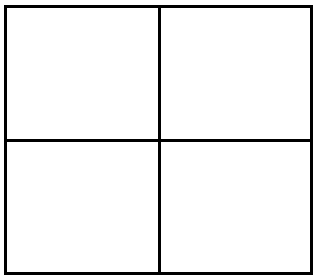
_____ chance of not having the deformity but **being a carrier**, which equates to_____%.

_____ chance of not having the deformity and **not being a carrier**, which equates to_____%.

What is the predicted effect if August has a child with a partner who **shows the deformity**?

Partner

August



_____chance of **having the deformity**, which equates to_____%.

_____ chance of not having the deformity but **being a carrier**, which equates to_____%.

_____ chance of not having the deformity and **not being a carrier**, which equates to_____%.

30. Tape the data table below and circle any disagreements between the book and your math:

31. Does your math match the math in the book? Yes No

32. Who were the partners when the math matched?_____

_____

33. Who were the partners when the math did not match?_____

For this case the book said _____

_____

but I think the probability is _____

The book also said _____

_____

but I think the probability is _____

34. If Via has a child with the deformity, what combination of alleles in her and her partner caused this effect?

Via x Partner _____

Gene: Gene: _____

_____

Child _____

Gene: _____

Pullman Family Member	Partner	(From Book) % of Children having the Deformity	(From Book) % of Children that are Carriers	(From Book) % of Children that are Not Carriers	(From Math) % of Children having the Deformity	(From Math) % of Children that are Carriers	(From Math) % of Children that are Not Carriers