**Genetics with a Smile**

**Introduction**

**Purpose**

To investigate single and double gene trait expression and define some human genetic inheritance patterns.

**Discussion**

Different patterns of inheritance are observed depending on the condition: Autosomal Recessive Inheritance (Sickle Cell, Phenylketonuria, Cystic Fibrosis), Autosomal Dominant Inheritance (Huntington’s, Achondroplasia, Aneuploidy), and Sex-linked inheritance (e.g. hemophilia, pattern baldness). Most traits follow Mendelian principles. Traits can be determined in one of two main pathways: autosomal and gametal. Humans have 22 pairs of autosomes, containing the gene that constitute most of our traits. There are, however, traits that stem directly from the sex cells (gametes) known as sex-determination traits and sex-linked traits. Sex (gender) is determined by the sex cells being XX (female) or Xy (male).



**Part A – Smiley Face Traits**

1. Obtain a large coin (e.g. quarter). You will flip the coin twice, once to represent the mother and once to represent the father. The parents are **heterozygous** for all the Smiley Face traits.
2. Flip the coin for the mother and then the coin for the father to determine the allele for each trait that the parents passed on to their offspring. If the coin lands heads up, it represents the dominant allele (capital letter). If the coin lands tails up, it represents the recessive allele (lower case letter).
3. Record the results for each coin toss by circling the correct letter in Table 1.
4. After both coins are flipped for a trait, use these results and the **Smiley Face Traits**, to determine and record the genotype and resulting phenotype in Table 1 for each trait.

**Table 1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Trait** | **Female** | **Male** | **Genotype** | **Phenotype** |
| Face Shape | **C c** | **C c** |  |  |
| Eye Shape | E e | E e |  |  |
| Hair Style | S s | S s |  |  |
| Smile | T t | T t |  |  |
| Ear Style | V v | V v |  |  |
| Nose Style | D d | D d |  |  |
| Face Color | Y y | Y y |  |  |
| Eye Color | B b | B b |  |  |
| Hair Length | L l | L l |  |  |
| Freckles | F f | F f |  |  |
| Nose color | R Y | R Y |  |  |
| Ear Color | P T | P T |  |  |

**Part B: Is it a boy or girl?**

To determine the sex of your smiley face, flip the coin for the male parent. Heads equals X and tails equals Y. **XX – FEMALE (Add pink bow in hair) XY – MALE**

**Table 2**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Female | Male | Genotype | Phenotype |
| **SEX** | **X X** | **X Y** |  |  |

**Smiley Face Traits**

***Face Shape Nose Style***

Circle (C) Oval (c) Down (D) Up (d)

***Eye Shape Face Color Eye Color***

Star (E) Blast (e) Yellow (Y) Blue (B)

 Green (y) Red (b)

***Hair Style Hair Length Freckles***

Stright (S) Curly (s) Long (L) Present (F)

││││││ Short (l) Absent (f)

***Smile Nose Color Ear Color***

Thick (T) Thin (t) Red (RR) Hot Pink (PP)

 Orange (RY) Purple (PT)

 Yellow (YY) Teal (TT)

***Ear Style***

Curved (V) Pointed (v)

**Part C: Create Your Smiley Face!**

1. Use the **Smiley Face Traits** on the previous page and the results from Tables 1 and 2 to create a sketch of your smiley face offspring in the box below.

|  |
| --- |
|  |

1. Name your “offspring”.

3. Which traits were a result of incomplete dominance?

4. What is the probability that a smiley face will have a green face? 1 out of 4 or 25 %. Create a Punnett square to help you find your answer.

Genotype of parents: **\_\_\_x\_\_\_**

F1 generation

Genotype Phenotype

*\_\_* % *\_\_* %

 Punnett Square (genotype F1 generation)

|  |  |  |
| --- | --- | --- |
| gametes |  |  |
|  |  |  |
|  |  |  |

5. What is the probability that a smiley face will have an orange nose? \_\_\_\_\_ out of \_\_\_\_\_ or \_\_\_\_ % Create a Punnett square to help you find your answer.

Genotype of parents: **\_\_\_x\_\_\_**

F1 generation

Genotype Phenotype

 Punnett Square (genotype F1 generation)

|  |  |  |
| --- | --- | --- |
| gametes |  |  |
|  |  |  |
|  |  |  |

6. How would the smiley faces change if one of the parents were homozygous dominant for all the traits while the other was heterozygous?

Genotype of parents: **\_\_\_x\_\_\_**

F1 generation

Genotype Phenotype

*\_\_* *\_\_* %

Punnett Square (genotype F1 generation)

|  |  |  |
| --- | --- | --- |
| gametes |  |  |
|  |  |  |
|  |  |  |

7. How would the smiley faces change if one of the parents were recessive for all the traits while the other was heterozygous?

Genotype of parents: **\_\_\_x\_\_\_**

F1 generation

Genotype Phenotype

*\_\_* % *\_\_* %

Punnett Square (genotype F1 generation)

|  |  |  |
| --- | --- | --- |
| gametes |  |  |
|  |  |  |
|  |  |  |

**Conclusions**

1. Why did you only need to flip the male parent coin to determine the sex of your smiley face?

2. What is the source of expression for all the traits except sex determination in this lab?

3. Define “affected” and “carrier” in terms of genetic diseases.

4. What is an autosomal recessive disease and is it transmitted?

5. What is an autosomal dominant disease and how is it transmitted?

**Bibliography**

Genetics with a Smile Lab. *Lab Worksheet*. Biology Course Site, Week 17. Learning CTR Online, n.d. Web. 4 Jan. 2023. <[www.learningctronline.com](http://www.learningctronline.com)/biology-course-site-s1>.

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Answers

3. Which traits were a result of incomplete dominance?

***Eye, nose and ear color all had more than one gene involved with intermediate dominance.***

4. What is the probability that a smiley face will have a green face? 1 out of 4 or 25 %. Create a Punnett square to help you find your answer.

Genotype of parents: **Yy x Yy**

F1 generation

Genotype Phenotype

**2/4 YY ¼ Yy ¼ yy**

***75* % Yellow *25* % Green**

*\_\_* % *\_\_* %

 Punnett Square (genotype F1 generation)

|  |  |  |
| --- | --- | --- |
| gametes | ***Y*** | ***y*** |
| ***Y*** | **YY** | **Yy** |
| ***y*** | **Yy** | **yy** |

5. What is the probability that a smiley face will have an orange nose? **2** out of **4** or **50 %**. Create a Punnett square to help you find your answer.

Genotype of parents: **RY x RY**

F1 generation

Genotype Phenotype

**¼ RR 2/4 RY ¼ YY ¼ yy**

***25* % Red 50% Orange *25* % Yellow**

*\_\_* % *\_\_* %

 Punnett Square (genotype F1 generation)

|  |  |  |
| --- | --- | --- |
| gametes | ***R*** | ***Y*** |
| ***R*** | **RR** | **RY** |
| ***Y*** | **RY** | **YY** |

6. How would the smiley faces change if one of the parents were homozygous dominant for all the traits while the other was heterozygous?

Genotype of parents: **YY x Yy**

F1 generation

Genotype Phenotype

**2/4 YY 2/4 Yy *100* % Yellow**

*\_\_* *\_\_* %

Punnett Square (genotype F1 generation)

|  |  |  |
| --- | --- | --- |
| gametes | ***Y*** | ***y*** |
| ***Y*** | **YY** | **Yy** |
| ***Y*** | **YY** | **Yy** |

**A homozygous parent with a heterozygous parent would produce F1 offspring that were all dominant in their phenotype (e.g. yellow).**

7. How would the smiley faces change if one of the parents were recessive for all the traits while the other was heterozygous?

Genotype of parents: **Yy x yy**

F1 generation

Genotype Phenotype

**2/4 Yy 2/4 yy**

***50* % Yellow *50* % Green**

*\_\_* % *\_\_* %

Punnett Square (genotype F1 generation)

|  |  |  |
| --- | --- | --- |
| gametes | ***y*** | ***y*** |
| ***Y*** | **Yy** | **Yy** |
| ***y*** | **yy** | **yy** |

**A homozygous recessive parent with a heterozygous parent would produce F1 offspring that were 50% dominant (e.g. yellow) and 50% recessive (e.g. green) in their phenotype.**

**Conclusions**

1. Why did you only need to flip the male parent coin to determine the sex of your smiley face?

**Gender (sex) is determined by the sex chromosomes. Males possess the “y” chromosome. Whereas females possess two “X” chromosomes.**

2. What is the source of expression for all the traits except sex determination in this lab?

**The traits are autosomal, meaning the gene are related to the 22 pairs of autosomes.**

3. Define “affected” and “carrier” in terms of genetic diseases.

* **Affected persons have a genetic disease or condition.**
* **Carriers do not have a genetic disease, but carry the gene which causes the disease.**
	+ **Carriers have one normal/dominant allele + one recessive allele for a disease.**
	+ **There is NO effect of the recessive allele on a carrier, because it has a normal/dominant allele that is expressed.**

4. What is an autosomal recessive disease and is it transmitted?

**When neither parent is affected, the trait cannot be dominant. Autosomal recessive traits occurs If any affected daughter has 2 unaffected parents the disease must be autosomal recessive. An affected individual must inherit a recessive allele from both parents, so both parents must have an allele.**

5. What is an autosomal dominant disease and how is it transmitted?

**Autosomal dominant is one of many ways that a trait or disorder can be passed down through families. In an autosomal dominant disease, if you get the abnormal**[**gene**](https://medlineplus.gov/ency/article/002371.htm)**from only one parent, you can get the disease. Often, one of the parents may also have the disease.**