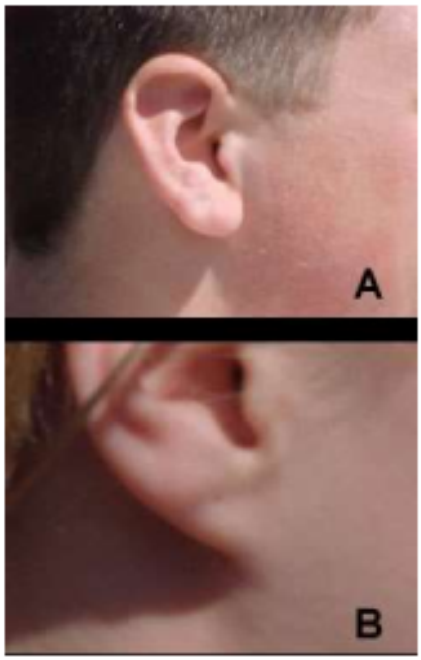
EXEMPLAR 2

Part A - THE PROPOSAL

Observation

Mary noticed several similarities and differences among her classmates but was particularly intrigued with the variation in earlobes. Some of her classmates had free hanging earlobes while some had attached earlobes. These observations led her to wonder about the general pattern of inheritance of this trait and how this trait is passed from parents to offspring.



A. Free hanging earlobes

B. Attached earlobes

http://www.windows2universe.org/earth/Life/genetics_puzzle.html

Hypothesis: Students with free hanging earlobes will have both parents with free hanging earlobes, while students with attached earlobes will have both parents with attached earlobes.

Aim: To investigate the pattern of inheritance for free hanging earlobes versus attached earlobes using data from classmates, their siblings and their parents.

Materials: paper; pencil; clip-board.

Method

1. Separate the class into two groups: those with free hanging earlobes and those with attached earlobes.

2. Record the presence or absence of free hanging earlobes versus attached earlobes for yourself, your siblings and your parents.

3. Select five additional classmates at random (if you have free hanging earlobes, select two (2) classmates from the "free hanging earlobes group" and three (3) from the "attached earlobes group". If you have attached earlobes, select two (2) classmates from the "attached earlobes group" and three (3) from the "free hanging earlobes group"). Obtain earlobe information for them as well as their siblings and both of their parents.

4. Record the earlobe information for all six (6) students (include yourself), and their siblings and parents in a table.

5. Analyze the phenotypic information for both groups, assuming that the genes for this characteristic are inherited according to Mendelian genetics. Answer the following questions:

   (a) Did all students with free hanging earlobes have both parents and all siblings with free hanging earlobes?

   (b) Did all students with attached earlobes have both parents and all siblings with attached earlobes?

   (c) Assign genotypes to the parents and use Punnet squares and Mendelian genetics to predict the genotypes of the offspring (students and their siblings). Based on your analysis, are free hanging earlobes a dominant or recessive trait? Why or why not?

Expected Results

It is expected that students with free hanging earlobes will have both parents with free hanging earlobes and all sibling will free hanging earlobes. The same pattern is expected for those students with attached earlobes.

The critical analysis of this study will involve determining the genotype of the students, children and parents based on the phenotypes observed.

PART B- IMPLEMENTATION

Introduction

Genes control the physical appearance of an organism. Genotype represents the hereditary information or exact genetic makeup of an organism for a particular trait. The phenotype is the actual observed property resulting from the expression of those genes as a physical characteristic (For example, free hanging versus attached earlobes). For diploid organisms of which humans are an example, every gene comes in two copies or alternate forms known as alleles, one, which comes from the mother, and one, which comes from the father. The combination of these two alleles is called the genotype and it is this combination that controls our physical characteristics (phenotypes). The common means to express genotypes is to use a capital letter "E" for a dominant allele and a lower case letter "e" to represent a recessive allele.

Some physical traits are considered discrete traits because they are governed by one set of genes. The expression of those traits depends on whether the genotype is homozygous dominant (EE), heterozygous (Ee) or homozygous recessive (ee). In this experiment, the distribution and inheritance of those two discrete traits will be investigated. It will be assumed that only one pair of genes controls the traits free hanging versus attached earlobes and that this gene is inherited according to Mendelian Genetics.

Method

1. The class was separated into two groups: those with free hanging earlobes and those with attached earlobes.

2. The presence or absence of free hanging earlobes versus attached earlobes was recorded for my siblings, my parents and myself.

3. Five additional classmates were selected at random (Given that I have free hanging earlobes, two (2) additional classmates were selected from the "free hanging earlobes" group" and three (3) from the "attached group". If I had had attached earlobes, 2 additional classmates would have been selected from the "attached group" and three (3) from the "free hanging earlobes group"). Earlobe information for my selected classmates as well as their siblings and both of their parents was collected.

4. The earlobe information for all six (6) students (including myself) and their siblings and parents were recorded in a table.

5. The phenotypic information for both groups was analyzed. The following questions were explored:

    (a) Did all students with free hanging earlobes have both parents and all siblings with free hanging earlobes?

    (b) Did all students with attached earlobes have both parents and all siblings with attached earlobes?

    (c) Assign genotypes to the parents and use Punnett squares and Mendelian genetics to predict the genotypes of the offspring (students and their siblings). Based on your analysis, are free hanging earlobes a dominant or recessive trait? Why or why not?

Results

TABLE 1 -SHOWING EARLOBE INFORMATION FOR THE 6 STUDENTS, THEIR SIBLINGS AND THEIR PARENTS

#	Group 1: Free Hanging	Siblings	Parents	#	Group 2: Attached Earlobe	Siblings	Parents
1.	Michael*	Tyson- *Free*	Mom: *Free* Dad: *Free*	**4.**	Veronica	Ty-*Attached* Mike-*Attached*	Mom: *Attached* Dad: *Attached*
2.	Shawon	Nekisha-*Free* Yohan-*Free*	Mom: *Attached* Dad: *Free*	**5.**	Shantelle	Chris-*Attached* Leonnie-Free	Mom: *Free* Dad: *Free*
3.	Allison	Kevin-*Attached* Jacob-*Attached* Maxine-*Free*	Mom: *Free* Dad: *Attached*	**6.**	Tyson	Tanisha-*Free*	Mom: *Free* Dad: *Attached*

Free- Free hanging earlobes
Attached- Attached earlobes
(*) Represents person conducting the experiment
Note: Not all children with attached earlobes had both parents with attached earlobes, nor did all children with free hanging earlobes have both parents with free hanging earlobes.

PUNNET SQUARES: Based on the observations, we will assume free hanging earlobes to be a dominant trait. Homozygous dominant (AA) as well as heterozygous (Aa) will represent Free Hanging Earlobes; while homozygous recessive (aa) can only represent Attached Earlobes.

1. Possible Genotype of Michael's parents and those of the children.

		DAD: Free	
		E	E
MOM: Free	E	EE	EE
	E	EE	EE

All children would have free hanging earlobes.

2. Possible Genotype of Shawon's parents and those of the children.

		DAD: Free	
		E	E
MOM: Attached	e	Ee	Ee
	e	Ee	Ee

All children would still have free hanging earlobes but their genotype would be heterozygous (Ee). Because free hanging is dominant to attached, having one copy of the "E" would be enough to have children with free hanging earlobes.

3. Possible Genotype of Allison's parents and those of the children.

		DAD: attached	
		e	e
MOM: Free	E	Ee	Ee
	e	ee	ee

Half of the children could have free hanging and half could have attached. The Mendelian ratio would be 1:1.

4. Possible Genotype of Veronica's parents and those of the children.

		DAD: attached	
		e	e
MOM: Attached	e	ee	ee
	e	ee	ee

If both parents are homozygous recessive (ee)/Attached earlobes, then all children would have attached earlobes.

5. Possible Genotype of Shantelle's parents and those of the children.

		DAD: Free	
		E	e
MOM: Free	E	EE	Ee
	e	Ee	ee

If both parents were heterozygous, they would still show free hanging earlobes. However, their children could either display free hanging or attached earlobes. The ratio would be 3:1

6. Possible Genotype of Tyson's parents and those of the children.

		DAD: Attached	
		e	e
MOM:	E	Ee	Ee
	e	ee	ee

If the mom is heterozygous (Ee) and the dad homozygous recessive (ee), then they could have children with free hanging ear lobes or attached earlobes in a ratio of 1:1.

Discussion

Simple dominance is a case where a single dominant allele will mask the expression of a single recessive allele. As such, persons with a physical characteristic only need one parent to show that trait for it to show up in the children. In the case of simple dominance, a person with the dominant trait could either be (EE or Ee) because only 1 of the dominant alleles is necessary to show the trait.

Information on phenotypes of parents can be used to create monohybrid crosses using Punnet squares to determine Mendelian ratios regarding possible expression of traits in offspring. The prediction is simply a matter of listing all the possible combinations of alleles in for a given offspring/child. From these results it will be possible to determine whether free hanging or attached earlobes is a dominant trait.

From the phenotypic data and Punnet square crosses it was clear that our hypothesis was not fully supported. Two parents with free hanging earlobes can still have children with attached earlobes because they could both be heterozygous dominant. A cross between Ee x Ee would result in a 3:1 phenotypic ratio of "Free-Hanging" to "Attached". However, two parents with homozygous dominant genotype EE x EE could only produce children with free hanging earlobes. Two parents with attached earlobes (homozygous recessive alleles) ee x ee could only have children with attached earlobes. Other combinations are also possible, e.g. example, Ee x ee or EE x ee.

Conclusion

"Free Hanging" earlobe is a dominant trait. For a child to have free hanging earlobes, he only needs at least one parent to have free hanging earlobes because the "E" allele masks the "e" allele. For a person to show attached earlobes, he/she would need to get an "e" allele from each parent. Both parents will have to carry the recessive form of the gene, even though both may have 'free hanging' ear lobes

Limitations

Every effort was made to reduce experimental error in this experiment. However, the experiment may be improved by:

1. Including information on grandparents;

2. Also, care must be taken with obtaining accurate information on the phenotype of their siblings and parents, from classmates.

Reflections

From this investigation, I have acquired a better understanding of genetics including genes, alleles, genotype versus phenotype, and Mendelian ratios. I can now appreciate how traits are passed on from one generation to another using information from a simple survey. I now realize that some traits are dominant while others are recessive and that it is our genotype that determines whether a trait will be expressed as a physical characteristic (for example, hair color, freckles, dimples, free hanging versus attached earlobes). This investigation also has applications to the study of genetic diseases, which can also be passed on from parent to offspring. One of the most striking things I learned from this investigation is that both parents can have free hanging earlobes but their child could still be born with attached earlobes. This could apply to cases where parents appear normal but a child is born with a genetic disorder. Overall, this was an interesting practical where I got to apply critical thinking skills to answer questions about heredity.