



SCIENCE DISSECTED

Inherited Vs. Environmentally Influenced Human Traits Model-Evidence Link Diagram (MEL)

Traits can either be determined by DNA or they can be influenced by outside factors. The color of an animal's coat or the shape of a plant's leaves are examples of physical traits that are determined by DNA. Other factors like those found in the environment in which an organism lives can affect the expression of inherited traits as well.

The term 'environmentally influenced' refers to the pressure the environment places on an organism in the expression of certain traits. This issue of Science Dissected provides an instructional resource for teachers to present students with the opportunity to examine several pieces of evidence compiled about human traits and how they are inherited to critically evaluate two competing models of trait expression.

Model A: All inherited genetic traits are the result of a person's DNA with NO other factors affecting their expression.

Model B: Inherited genetic traits are NOT only the result of a person's DNA, but other factors affect the expression of those traits.

Evidence #1: Data shows that the basic underlying principles of heredity of genetic traits is fundamentally the same for all complex life forms — including 2 forms of an allele — dominant and recessive.

Evidence #2: According to research we know that even though a person may inherit a gene predisposing him to diabetes; if he exercises regularly and keeps his weight under control; he may never develop the disease.

Evidence #3: Some scientists are researching the epigenetic effects on the expression of traits.

Evidence #4: Traits are passed on from parent to child through DNA in 23 pairs of chromosomes. It is the genes in these chromosomes that will decide the inherited traits in humans.

Evidence #5: Many researchers agree that child development is a complex interaction between nature and nurture.

The following is a suggestion for using this MEL with students:

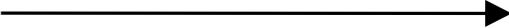
1. Hand out the Human Traits MEL diagram (page 1). Instruct students to read the directions, descriptions of Model A and Model B, and the five evidence texts presented.
2. Handout the five evidence text pages.
3. Instruct students to carefully review the Evidence #1 text page (page 3), then construct two lines from Evidence #1; one to Model A and one to Model B. Remind students that the shape of the arrow they draw indicates their plausibility judgment (potential truthfulness) connection to the model.
4. Repeat for Evidence #2-5
5. Handout page 2 for the students to critically evaluate their links and construct understanding.

Once students have completed page 2, they can then engage in collaborative argumentation as they compare their links and explanations with that of their peers. Students should be given the opportunity to revise the link weighting during the collaborative argumentation exercise. If time permits, have students reflect on their understanding of Inherited vs. Environmentally Influenced Traits and create questions that they might explore in the future.

Name: _____ Period: _____

Directions: draw two arrows from each evidence box. One to each model. You will draw a total of 10 arrows.

Key:

	The evidence supports the model
	The evidence STRONGLY supports the model
	The evidence contradicts the model (shows its wrong)
	The evidence has nothing to do with the model

Standard: L.8.A.4

Evidence #1:
Data shows that the basic underlying principles of heredity of genetic traits is fundamentally the same for all complex life forms – including 2 forms of an allele – Dominant and Recessive.

Evidence #2:
According to research, we know that even though a person may inherit a gene predisposing him to diabetes-- if he exercises regularly and keeps his weight under control; he may never develop the disease.

Model A
All inherited genetic traits are the result of a person's DNA **with NO** other factors affecting the expression of those traits.

Model B
Inherited genetic traits are **not only** the result of a person's DNA, but also other factors that affect the expression of those traits.

Evidence #3
Some scientists are researching the epigenetic effects (chemical markers that attach to genes and turn them on and off) on the expression of traits.

Evidence #4
Traits are passed on from parent to child through DNA in 23 pairs of chromosomes; 1 set from each parent. It is the genes in these chromosomes that will decide the inherited traits in humans.

Evidence #5
Many researchers agree that child development is a complex interaction between nature and nurture.

Provide a reason for three of the arrows you have drawn. **Write your reasons for the three most interesting or important arrows.**

- A. Write the number of the evidence you are writing about.
- B. Circle the appropriate descriptor (**strongly supports** | **supports** | **contradicts** | **has nothing to do with**).
- C. Write the letter of the model you are writing about.
- D. Then write your reason.

1. Evidence # ____ **strongly supports** | **supports** | **contradicts** | **has nothing to do with** Model ____ because:

2. Evidence # ____ **strongly supports** | **supports** | **contradicts** | **has nothing to do with** Model ____ because:

3. Evidence # ____ **strongly supports** | **supports** | **contradicts** | **has nothing to do with** Model ____ because:

4. Circle the plausibility of each model. [Make two circles. One for each model.]

	Greatly implausible (or even impossible)										Highly Plausible
Model A	1	2	3	4	5	6	7	8	9	10	
Model B	1	2	3	4	5	6	7	8	9	10	

5. Circle the model which you think is correct. [Only circle one choice below.]

Very certain that Model A is correct	Somewhat certain that Model A is correct	Uncertain if Model A or B is correct	Somewhat certain that Model B is correct	Very certain that Model B is correct
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Evidence #1: Data shows that the basic underlying principles of heredity of genetic traits is fundamentally the same for all complex life forms – including 2 forms of an allele – Dominant and Recessive.

Downloaded from: anthro.palomar.edu/medel/mendel_1.htm

Mendel's Genetics:

For thousands of years farmers and herders have been selectively breeding their plants and animals to produce more useful hybrids . It was somewhat of a hit or miss process since the actual mechanisms governing inheritance were unknown. Knowledge of these genetic mechanisms finally came as a result of careful laboratory breeding experiments carried out over the last century and a half.



Hybridized domesticated horses



Gregor Mendel
1822-1884

By the 1890's, the invention of better microscopes allowed biologists to discover the basic facts of cell division and sexual reproduction. The focus of genetics research then shifted to understanding what really happens in the transmission of hereditary traits from parents to children. A number of hypotheses were suggested to explain heredity, but Gregor Mendel , a little known Central European monk, was the only one who got it more or less right. His ideas had been published in 1866 but largely went unrecognized until 1900, which was long after his death. His early adult life was spent in relative obscurity doing basic genetics research and teaching high school mathematics, physics, and Greek in Brno (now in the Czech Republic). In his

later years, he became the abbot of his monastery and put aside his scientific work.

While Mendel's research was with plants, the basic underlying principles of heredity that he discovered also apply to people and other animals because the mechanisms of heredity are essentially the same for all complex life forms.



Common edible peas

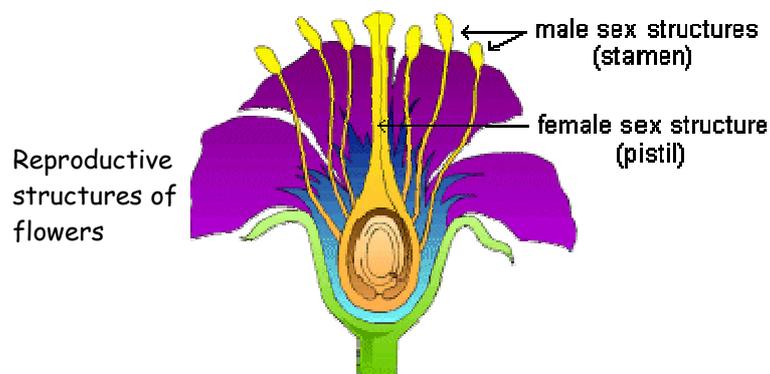
Through the selective cross-breeding of common pea plants (*Pisum sativum*) over many generations, Mendel discovered that certain traits show up in offspring without any blending of parent characteristics. For instance, the pea flowers are either purple or white--intermediate colors do not appear in the offspring of cross-pollinated pea plants. Mendel observed seven traits that are easily recognized and apparently only occur in one of two forms:

1. flower color is purple or white
2. flower position is axil or terminal
3. seed color is yellow or green
4. pod shape is inflated or constricted

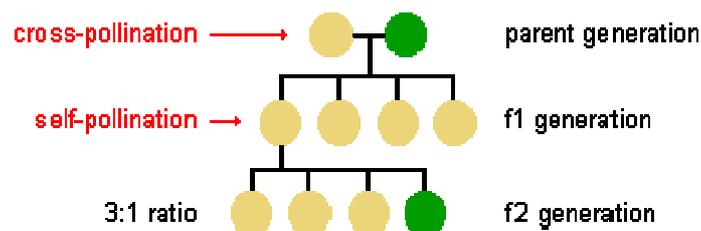
3. stem length is long or short 7. pod color is yellow or green
 4. seed shape is round or wrinkled

This observation that these traits do not show up in offspring plants with intermediate forms was critically important because the leading theory in biology at the time was that inherited traits blend from generation to generation. Most of the leading scientists in the 19th century accepted this "blending theory." Charles Darwin proposed another equally wrong theory known as "pangenesis" 🦋. This held that hereditary "particles" in our bodies are affected by the things we do during our lifetime. These modified particles were thought to migrate via blood to the reproductive cells and subsequently could be inherited by the next generation. This was essentially a variation of Lamarck's incorrect idea of the "inheritance of acquired characteristics."

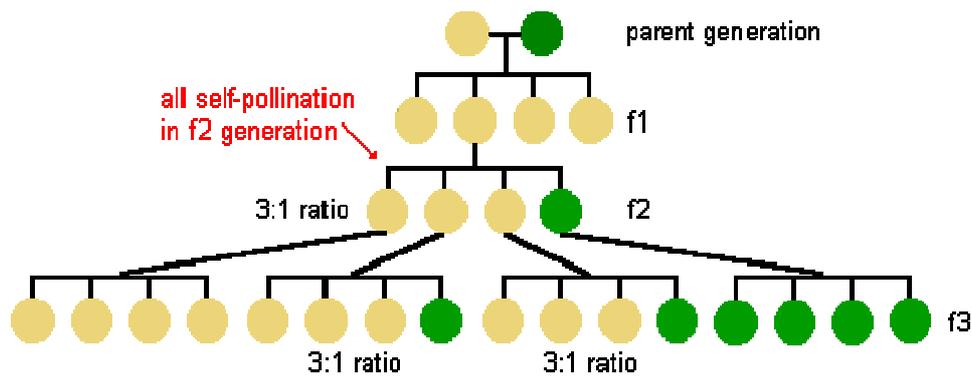
Mendel picked common garden pea plants for the focus of his research because they can be grown easily in large numbers and their reproduction can be manipulated. Pea plants have both male and female reproductive organs. As a result, they can either self-pollinate themselves or cross-pollinate with another plant. In his experiments, Mendel was able to selectively cross-pollinate purebred plants with particular traits and observe the outcome over many generations. This was the basis for his conclusions about the nature of genetic inheritance.



In cross-pollinating plants that either produce yellow or green pea seeds exclusively, Mendel found that the first offspring generation (f1) always has yellow seeds. However, the following generation (f2) consistently has a 3:1 ratio of yellow to green.



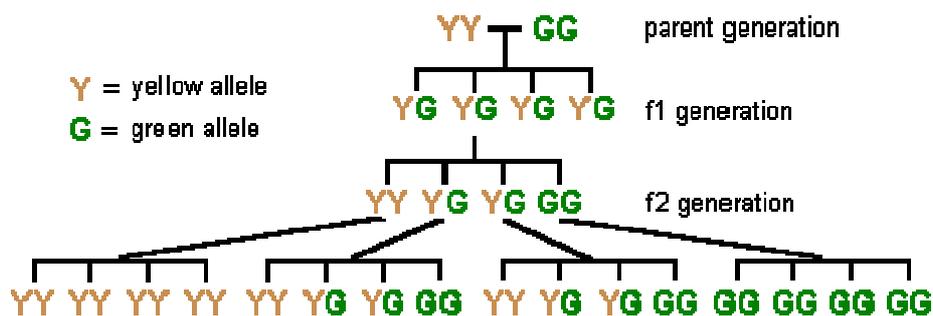
This 3:1 ratio occurs in later generations as well. Mendel realized that this was the key to understanding the basic mechanisms of inheritance.



He came to three important conclusions from these experimental results:

1. that the inheritance of each trait is determined by "units" or "factors" that are passed on to descendants unchanged (these units are now called genes)
2. that an individual inherits one such unit from each parent for each trait
3. that a trait may not show up in an individual but can still be passed on to the next generation.

It is important to realize that, in this experiment, the starting parent plants were **homozygous** for pea seed color. That is to say, they each had two identical forms (or **alleles**) of the gene for this trait--2 yellows or 2 greens. The plants in the f1 generation were all **heterozygous** . In other words, they each had inherited two different alleles--one from each parent plant. It becomes clearer when we look at the actual genetic makeup, or **genotype** , of the pea plants instead of only the **phenotype** , or observable physical characteristics.



Note that each of the f1 generation plants (shown above) inherited a Y allele from one parent and a G allele from the other. When the f1 plants breed, each has an equal chance of passing on either Y or G alleles to each offspring.

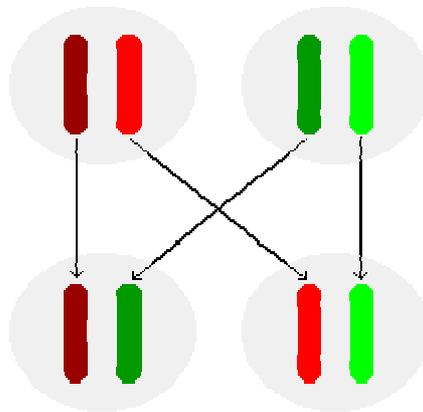
With all of the seven pea plant traits that Mendel examined, one form appeared **dominant** over the other, which is to say it masked the presence of the other allele. For example, when the genotype for pea seed color is YG (heterozygous), the phenotype is yellow. However, the

dominant yellow allele does not alter the **recessive** green one in any way. Both alleles can be passed on to the next generation unchanged.

Mendel's observations from these experiments can be summarized in two principles:

1. the principle of segregation
2. the principle of independent assortment

According to the **principle of segregation**, for any particular trait, the pair of alleles of each parent separate and only one allele passes from each parent on to an offspring. Which allele in a parent's pair of alleles is inherited is a matter of chance. We now know that this segregation of alleles occurs during the process of sex cell formation (i.e., meiosis).



Segregation of alleles in the production of sex cells

According to the **principle of independent assortment**, different pairs of alleles are passed to offspring independently of each other. The result is that new combinations of genes present in neither parent are possible. For example, a pea plant's inheritance of the ability to produce purple flowers instead of white ones does not make it more likely that it will also inherit the ability to produce yellow pea seeds in contrast to green ones. Likewise, the principle of independent assortment explains why the human inheritance of a particular eye color does not increase or decrease the likelihood of having 6 fingers on each hand. Today, we know this is due to the fact that the genes for independently assorted traits are located on different chromosomes .

These two principles of inheritance, along with the understanding of unit inheritance and dominance, were the beginnings of our modern science of genetics. However, Mendel did not realize that there are exceptions to these rules. Some of these exceptions will be explored in the third section of this tutorial and in the Synthetic Theory of Evolution tutorial.

By focusing on Mendel as the father of genetics, modern biology often forgets that his experimental results also disproved Lamarck's theory of the inheritance of acquired characteristics described in the Early Theories of Evolution tutorial. Mendel rarely gets credit for this because his work remained essentially unknown until long after Lamarck's ideas were widely rejected as being improbable.

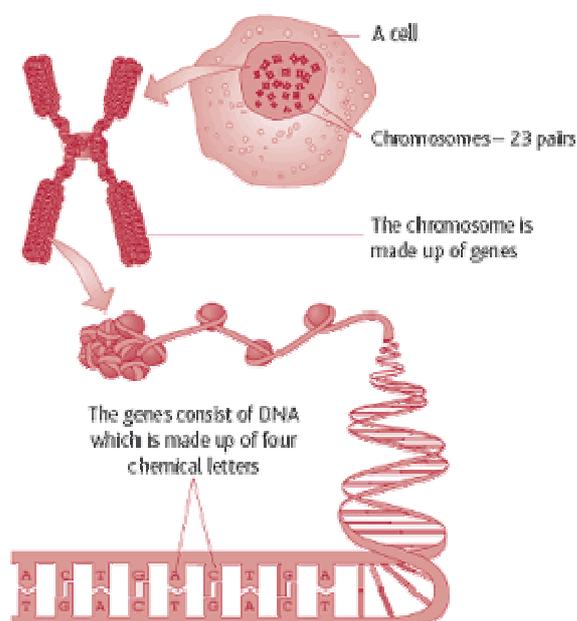
Evidence #2: According to research, we know that even though a person may inherit a gene predisposing him to diabetes-- if he exercises regularly and keeps his weight under control; he may never develop the disease.

Your Genes And The Environment You Live In

Downloaded from: www.truegenetics.com/lifestyle/index.htm

What Are "Genes"?

Inside your cells, there are 23 pairs of chromosomes that carry your genetic information. You received one set of chromosomes from your mother and one set of chromosomes from your father. Each chromosome is made up of two long strands of deoxyribonucleic acid (also known as DNA). The two strands connect such that the chemical letters, also known as nucleotides, on each strand pair up. The many combinations of the four nucleotides in DNA (adenine [A], thymine [T], guanine [G], and cytosine [C]) spell the language known as your genetic code.



There are more than six billion nucleotide pairs in your DNA, some of which accounts for your genes. A gene can be defined as a sequence of nucleotides that controls one or more particular characteristics you received from your parents. Genes influence your physical traits, the likelihood of suffering from a specific disease or health condition, and the way your body responds to the environment you live in.

What is a "SNP"?

All humans are similar for 99% of the same genetic code. So what makes you different from everyone else? Single nucleotide polymorphisms, or SNPs (pronounced "Snips") , make up some of these differences. These are variations in the nucleotides on certain genes. For example, a portion of your genetic code may be AATGCCAG while the same portion of your neighbor's code may be AATGCCCG. This SNP is one of the things that make you different from your neighbor. There are over 12 million SNPs throughout each of our genomes. Scientists have now developed technology that can use these SNPs to discover genetic regions that have an effect on the likelihood that a person will develop a trait or disease.

What Is a "Trait"?

A trait is a characteristic that is passed down from your parents through genes. Traits describe characteristics such as eye color, weight, or the presence or absence of a disease or condition. One gene or multiple genes can determine what traits you will have. As an example, your eye color depends on what genes were passed on to you from your parents and the combination of SNPs in those genes.



What Does "Environment" Mean?

While your genes are something inside your cells that you get from your parents, your environment is the forces outside your body that affect whether or not you will develop a particular trait or disease. Simply having a specific gene does not determine whether or not you will get a specific trait or disease. There may be environmental factors that play a role in determining whether or not you will develop a specific trait or disease. For example, you may have genes that indicate that you have a high risk of developing diabetes. However, if you exercise regularly, keep your weight under control, and make healthy lifestyle choices, you can effectively control your environment and reduce your risk for developing diabetes. As a result of controlling your environment, even if you have the "diabetes gene," it is possible that you may never develop diabetes.

How Are Your Genes & Environment Related to Your Traits?

Together your genes and your environment interact to determine your traits, or the characteristics that describe you. The debate surrounding whether genes or the environment plays a larger role is sometimes referred to as "nature versus nurture."



This concept can be illustrated by thinking about weight. You may have inherited the gene (or genes) from your parents that indicate you have a chance of becoming obese. Even if you are not obese, knowing that you are at a higher risk of becoming obese may encourage you to talk to your doctor about preventative measures. Your doctor may discuss healthy eating habits, exercise routines that are appropriate for you, or other ways to control your weight. Such preventative measures may not only decrease your risk of developing obesity, but they may also decrease your risk of developing other diseases associated with obesity such as high blood pressure, diabetes, or heart disease. In this way, the knowledge you have regarding your genes will allow you to become proactive about preventing the disease (and possibly other diseases), thus using your environment to influence your traits.

Evidence #3: Some scientists are researching the epigenetic effects (chemical markers that attach to genes and turn them on and off) on the expression of traits.

Lifestyle Factors May Alter Genetic Traits, Study Finds

www.npr.org/story/story.php?storyID=130703719

A new scientific study appearing in this week's issue of the journal *Nature* is challenging familiar ideas about genetic inheritance.

We can't change the genes we received from our parents. But our genes are controlled by a kind of instruction manual made up of billions of chemical markers on our DNA, and those instructions can be rewritten by our circumstances — for instance, by obesity. According to the new research, they can even be passed along to children.

The study was directed by Margaret Morris, an obesity researcher at the University of New South Wales in Sydney. Morris had previously explored the reasons why the children of obese mothers often become overweight themselves. But her attention shifted when a new graduate student from Malaysia arrived in her laboratory.

"She noted, in a clinic, that when a child arrived for weight management, usually both parents were obese, not just the mother," says Morris.

This wasn't too surprising. It makes sense that if a father is genetically predisposed to obesity, his daughter might be, too. But Morris wondered whether she might be seeing more than genes at work.

The Consequences Of Overeating

Morris set up an experiment with lab rats to see if the biological consequences of a father overeating could somehow get passed on to his daughters. "This is a study that I did for love," she says. "I didn't really have much funding for it. I had to crib money from all over to do it."

Morris took a group of genetically identical male rats, and put half of them on a high-fat diet. Predictably, those rats got fat and suffered symptoms of diabetes.

Then all the rats mated with normal females and had children. Morris looked specifically at the daughters. All of them had a similar genetic makeup, but those with overweight fathers had some of the same problems that their dads did. They weren't overweight, but their production of insulin was impaired.

The Grammar Of DNA

Feinberg thinks he knows how this may be happening. It's an example of an "epigenetic" effect, which is his specialty.

This field — epigenetics — is getting a lot of attention these days. It refers to things in and around our DNA, such as billions of chemical markers that attach to it. Those markers are signals that turn genes on and off. They tell the genes of a liver cell to behave differently from genes in a blood cell, for instance.

The sequence of our DNA — the human genome — has been called the book of life. Feinberg has his own metaphor for the billions of added signals that he studies. If the genetic sequence is the words of the book, the epigenome is the grammar, he says. "It helps to tell what the genes are actually supposed to do, and puts them in context."

Our genes don't change, or if they do, it's a rare and random event. But the grammar of the epigenome is changing all the time. It can also be disrupted by chemicals we eat or breathe.

Apparently it can also be disrupted by obesity, because Feinberg thinks those fat dad rats in Australia created sperm cells with a different pattern of epigenetic marks on their DNA; that's how the effect showed up in their children.

Michael Skinner at Washington State University in Pullman says epigenetic effects are swinging the pendulum of scientific attention from the genetic code back toward the impact of environment.

"I think that we're eventually going to have sort of a merger of this," he says. "I think that we're going to have an appreciation of the fact that there is an environmental influence on biology that probably through more epigenetic mechanisms. There's also a baseline genetic element of biology. And the two combined will actually give us more information about how things work."

Much of epigenetics is still a mystery. Scientists would like to know, for instance, how often epigenetic signals are passed on from parent to child, or even grandchild. So Morris, in Australia, is hoping to repeat her experiment and see if the effect persists over multiple generations.

Evidence #4: Traits are passed on from parent to child through DNA in 23 pairs of chromosomes; 1 set from each parent. It is the genes in these chromosomes that will decide the inherited traits in humans.

Inherited Traits in Humans

Downloaded from: www.alltrait.com/inherited-traits-in-humans/

There are people, so there will be traits. What are traits- Simply put, traits are certain characteristics that humans have, their behavior patterns, the ability to react to certain situations in a particular way; and more importantly - certain physical attributes. It is what makes all of us human in the true sense. Now the thing about traits is that we inherit some of them, while others are acquired. Acquired traits would denote that the environment we've grown in, the kind of situations we've faced or any other such external factors have made us 'acquire' or 'take on' certain traits. Acquired traits would mainly refer to the behavior patterns. But inherited traits in humans is exactly the way it sounds - we inherit them. And the simplest way by which we can understand this is if we look at a pair of siblings. Chances are that they will look similar, have similar features, and have certain characteristic behavior patterns that they share. This is because they have inherited the traits.

There are several such inherited traits in humans. In fact, we rarely ever stop to think about these genetic traits in humans because they have been 'wired' into us (for the lack of a better word). They are ingrained and we therefore do not distinguish. There are inherited behaviors in humans like anger or cooking abilities, and these are more difficult to notice. What are more easily observable are the physical inherited traits in humans and that is what we will be dealing with today. So let us try and shed light on some of these inherited traits in humans through the following article. All in all, it'll make for a very interesting read and tell you a little something more about human genetics.

List of Inherited Traits in Humans

Traits are passed on from parent to child through genes and chromosomes which are made up of DNA. There are only 23 pairs of chromosomes in the human body (1 from each parent) but each of these chromosomes has several thousand genes in them. Some genes are dominant while others are recessive. The dominant genes are responsible for traits in humans, while recessive genes will only come into action if the dominant genes are missing. Thus it is these genes that will decide the inherited traits in humans. Read more on history of DNA.

Here is a list of inherited traits in humans. Use this list to see which category you fall under!

Earlobes

There are two kinds of earlobes. The attached earlobes and the detached earlobes. Attached

earlobes are those in which the lobes are joined to the side of the head. They appear to be one complete structure. Whereas detached earlobes are those in which the lobe seems as if it is detached. They appear hanging from the ear.

Dimples

Notice how some people have dimples while others don't- That's because a dimple is caused due to a dominant gene which carries the 'dimple' trait. People who do not have dimples carry a recessive gene of the 'dimple' trait and therefore they do not have dimples. Read more on genetic traits: dimples.

Sometimes we also see that the parents might not have dimples and yet a child has them. This is because they are passed on from the grandparents or even great grandparents. The dimple trait which remained as a recessive gene during the parents conception, will have become a dominant gene during the grandchild's conception and therefore comes about in the form of a dimple.

Tongue Rolling

Some people are able to roll their tongue while others can't. This is due to the working of the dominant and recessive gene. Some people have the dominant gene which enables them to roll their tongue while others don't. What is interesting to note is that it is a single gene that is responsible for the presence or lack of tongue rolling. And here's something to think about, 30% of all identical twins do not share the trait!

Cleft Chin

A cleft chin is rather uncommon and comes about in people as a result of a dominant gene and a recessive smooth chin gene. While in the majority of the human race, it works the other way round.

Hair Line

Notice how some people have a straight hairline and others might have a widow's peak- Let's get to the root of that. Most genes have variations in them called alleles. These determine the way things will shape up. For example, the hairline shape has two alleles '□ The widow's peak or straight. Now the factor which determines whether a person will have a straight hairline or a widow's peak is determined by the fact whether the alleles (1 from each parent) are two identical ones or not (recessive or dominant). When a dominant and recessive allele mix, the dominant trait will be observed. Which means that if a child gets a dominant straight hairline shape from one parent and a widow's peak from the other, his hairline will be straight (since it is dominant). It is only if there are two recessive genes that come together that they will manifest to form the corresponding hairline. If not, then as a rule, the dominant allele will form the result.

Freckles

These are caused by a dominant gene and their absence denotes a recessive gene.

Hair Appearance

Some people have straight hair while others have curly or wavy. It has been studied that curly hair is a dominant trait whereas straight is recessive. So for all of you who have straight hair, it is because of two recessive genes that it has come about.

Hand Clasping

Try this experiment. Clasp your hands together and interlock your fingers without thinking. Now check which thumb is on top - the right or left. There is no explanation for this one. But studies have found that 55% of people place their left thumb up, while 45% place their right. Even though this has no significance, it is rather interesting, won't you say-

Second Toe

Some people's second toe (after the big toe) is shorter than their big toe. While others' are longer than the big toe's length. There are theories that are formed that the latter means that the person is dominating, but that is of course not genetics!

PTC Tasting

For some the chemical Phenylthiocarbamide (PTC) tastes very bitter while for others it has no taste.

Thumb

Look at your thumb carefully - is it a straight thumb or a hitchhiker's thumb (one that is slightly bent backwards). A hitchhiker's thumb is rarer than a straight thumb.

Allergies

Many people inherit allergies from their parents. It is not necessarily always external factors that cause them. If a parent or both parents have some form of allergies, then there is a high chance that they'll be genetically passed on to the child.

Colorblindness

Colorblindness comes about because of a recessive allele that is present in the X chromosome. Since women have two X chromosomes, and one of these has the normal color vision allele, colorblindness in women is less likely. Whereas since men have only one X chromosome, and they happen to inherit one which has the allele for colorblindness, it will come about as a trait. Hence men suffer from this condition more than women do.

Vulcan Sign

Here is an interesting thing to try out. Spread your palm out and then try to do a Vulcan sign. Join the index and middle finger together and the fourth and the pinkie together to form a 'V' sign. (Keep the thumb out of this!) Can you do it- Or is it a strain- Some people can do it easily while others just can't!

Evidence #5: Many researchers agree that child development is a complex interaction between nature and nurture.

How Genetics Influence Child Development

Downloaded from: www.about.com

What determines how a child develops? In reality, it would be impossible to account for each and every influence that ultimately determines who a child becomes. What we can look at are some of the most apparent influences such as genetics, parenting, experiences, friends, family relationships and school to help us understand the influences that help contribute to a child's growth.

Think of these influences as building blocks. While most people tend to have the same basic building blocks, these components can be put together in an infinite number of ways. Consider your own overall personality. How much of who you are today was shaped by your genetic inheritance, and how much is a result of your lifetime of experiences?

This question has puzzled philosophers, psychologists and educators for hundreds of years and is frequently referred to as the nature versus nurture debate. Are we the result of nature (our genetic background) or nurture (our environment)? Today, most researchers agree that child development involves a complex interaction of both nature and nurture. While some aspects of development may be strongly influenced by biology, environmental influences may also play a role. For example, the timing of when the onset of puberty occurs is largely the results of heredity, but environmental factors such as nutrition can also have an effect.

From the earliest moments of life, the interaction of heredity and the environment works to shape who children are and who they will become. While the genetic instructions a child inherits from his parents may set out a road map for development, the environment can impact how these directions are expressed, shaped or even silenced. The complex interaction of nature and nurture does not just occur at certain moments or at certain periods of time; it is persistent and lifelong.

In this article, we'll take a closer look at how biological influences help shape child development. We'll learn more about how our experiences interact with genetics and learn about some of the genetic disorders that can have an impact on child psychology and development.

Going From One Cell to Trillions

At its very beginning, the development of a child starts when the male reproductive cell, or sperm, penetrates the protective outer membrane of the female reproductive cell, or ovum. The

sperm and ovum each contain chromosomes that act as a blueprint for human life. The genes contained in these chromosomes are made up of a chemical structure known as DNA (deoxyribonucleic acid) that contains the genetic code, or instructions, that make up all life. Except for the sperm and ova, all cells in the body contain 46 chromosomes. As you might guess, the sperm and ova each contains only contain 23 chromosomes. This ensures that when the two cells meet, the resulting new organism has the correct 46 chromosomes.

From Genotype to Phenotype

So how exactly do the genetic instructions passed down from both parents influence how a child develops and the traits they will have? In order to fully understand this, it is important to first distinguish between a child's genetic inheritance and the actual expression of those genes. A genotype refers to all of the genes that a person has inherited. The actual express of these traits is the person's phenotype. The phenotype can include physical traits, such as height and color or the eyes, as well as nonphysical traits such as shyness, a high strung temperament or a thirst for adventure.

Remember our building block metaphor from earlier? While our genotype may represent a blueprint for how children grow up, the way that these building blocks are put together determines how these genes will be expressed. Think of genes as something like a blueprint to a house. Two houses can be constructed from the exact same blueprint, but the materials chosen build each house can vary dramatically from one to the next.

Influences on Gene Expression

Whether or not a gene is expressed depends on two different things: the interaction of the gene with other genes and the continual interaction between the genotype and the environment.

- **Genetic Interactions:** Genes can sometimes contain conflicting information, and in most cases, one gene will win the battle for dominance. Some genes act in an additive way. For example, if a child has one tall parent and one short parent, the child may end up splitting the difference by being of average height. In other cases, some genes follow a dominant-recessive pattern. Eye color is one example of dominant-recessive genes at work. The gene for brown eyes is dominant and the gene for blue eyes is recessive. If one parent hands down a dominant brown eye gene while the other parent hands down a recessive blue eye gene, the dominant gene will win out and the child will have brown eyes.
- **Gene - Environment Interactions:** The environment a child is exposed to both in utero and throughout the rest of his or her life can also impact how genes are expressed. For example, exposure to harmful drugs while in utero can have a dramatic impact on later child development. Height is a good example of a genetic trait that can be influenced by

environmental factors. While a child's genetic code may provide instructions for tallness, the expression of this height might be suppressed if the child has poor nutrition or a chronic illness.

Genetic Abnormalities

Genetic instructions are not infallible and can go off track at times. Sometimes when a sperm or ovum is formed, the number of chromosomes may divide unevenly, causing the organism to have more or less than the normal 23 chromosomes. When one of these abnormal cells joins with a normal cell, the resulting zygote will have an uneven number of chromosomes. Researchers suggest that as many as half of all zygotes that form have more or less than 23 chromosomes, but most of these are spontaneously aborted and never develop into a full-term baby.

In some cases, about 1 in every 200 births, a baby is born with an abnormal number of chromosomes. In every case, the result is some type of syndrome with a set of distinguishing characteristics.

Down Syndrome

The most common type of chromosomal disorder is known as trisomy 21, or Down syndrome. In this case, the child has three chromosomes at the site of the 21st chromosomes instead of the normal two. Down syndrome is characterized by facial characteristics including a round face, slanted eyes and a thick tongue. Individuals with Down syndrome may also face other physical problems including heart defects and hearing problems. Nearly all individuals with Down syndrome experience some type of intellectual impairment, but the exact severity can vary dramatically. No matter the severity of the syndrome, early intervention can result in much better outcomes, allowing many people with Down syndrome to care for themselves and gain more independence.

Abnormalities of the Sex Chromosomes

The vast majority of newborns, both boys and girls, have at least one X chromosome. In some cases, about 1 in every 500 births, children are born with either a missing X chromosome or an additional sex chromosome. Klinefelter syndrome, Fragile X syndrome and Turner syndrome are all examples of abnormalities involving the sex chromosomes.

Klinefelter's syndrome is caused by an extra X chromosome and is characterized by a lack of development of the secondary sex characteristics and as well as learning disabilities.

Fragile X syndrome is caused when part of the X chromosome is attached to the other chromosomes by such a thin string of molecules that it seems in danger of breaking off. It can affect both males and females, but the impact can vary. Some with Fragile X show few if any signs, while others develop mild to severe mental retardation.

Turner syndrome occurs when only one sex chromosome (the X chromosome) is present. It affects only females and can result in short stature, a "webbed" neck and a lack of secondary sex characteristics. Psychological impairments associated with Turner syndrome include learning disabilities and difficulty recognizing emotions conveyed through facial expressions.

Final Thoughts

Clearly, genetics have an enormous influence on how a child develops. However, it is important to remember that genetics are just one piece of the intricate puzzle that makes up a child's life. Environmental variables, including parenting, culture, education and social relationships also play a vital role.