Summer Assignment

Howdy soon-to be 8th graders! Over the summer we are going to cover two topics that were not covered in the stage 8 Cambridge curriculum. These topics include: the structure and function of DNA, and Heredity. All summer assignments are due on the first day of school, **August 10th**. They must be all ready to turn in that Tuesday.

Directions

Assignment #1: DNA "The Double Helix." This is a simple informative worksheet. You must read, color the DNA strand, and answer the questions thoroughly. Please be sure to highlight, circle and annotate the short reading.

Assignment #2: Heredity. Read the information in the handout "Phenotypes, Genotypes....", which will enable you to do the practice questions. Your next task is to complete the practice punnett squares on the worksheet. Make one of your own examples using the worksheet practice critters to give you some ideas.

DNA -- THE DOUBLE HELIX

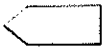
(modified from The Biology Corner - Worksheets and Lessons)

The nucleus is a small spherical, dense body in a cell. It is called the "control center" because it controls all the activities of the cell. Chromosomes, found in the nucleus, are microscopic, threadlike strands composed of the chemical DNA (short for deoxyribonucleic acid).

Chromosomes are composed of genes, which is a segment of DNA that codes for a particular protein which in turn codes for a trait. It is commonly referred to as the gene for baldness or the gene for blue eyes.

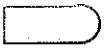
In 1953, James Watson and Francis Crick established the structure of DNA. The shape of DNA is a double helix, which is like a twisted ladder. The sides of the ladder are made of alternating sugar and phosphate molecules. The sugar is deoxyribose. Color all the phosphates red (labeled with a "p"). Color all the deoxyriboses blue (labeled with a "D").

The rungs of the ladder are pairs of 4 types of nitrogen bases. The bases are known by their coded letters A, G, T, C. These bases always bond in a certain way. Adenine will only bond to thymine. Guanine will only bond with cytosine. The bases can occur in any order along a strand of DNA. The order of these bases is the code that contains the instructions. For instance ATGCGCATAT would code for a different gene than CGATCGCGAT. A strand of DNA contains millions of bases.

Color the thymines orange. 

Color the adenines green. 

Color the guanines purple. 

Color the cytosines yellow. 

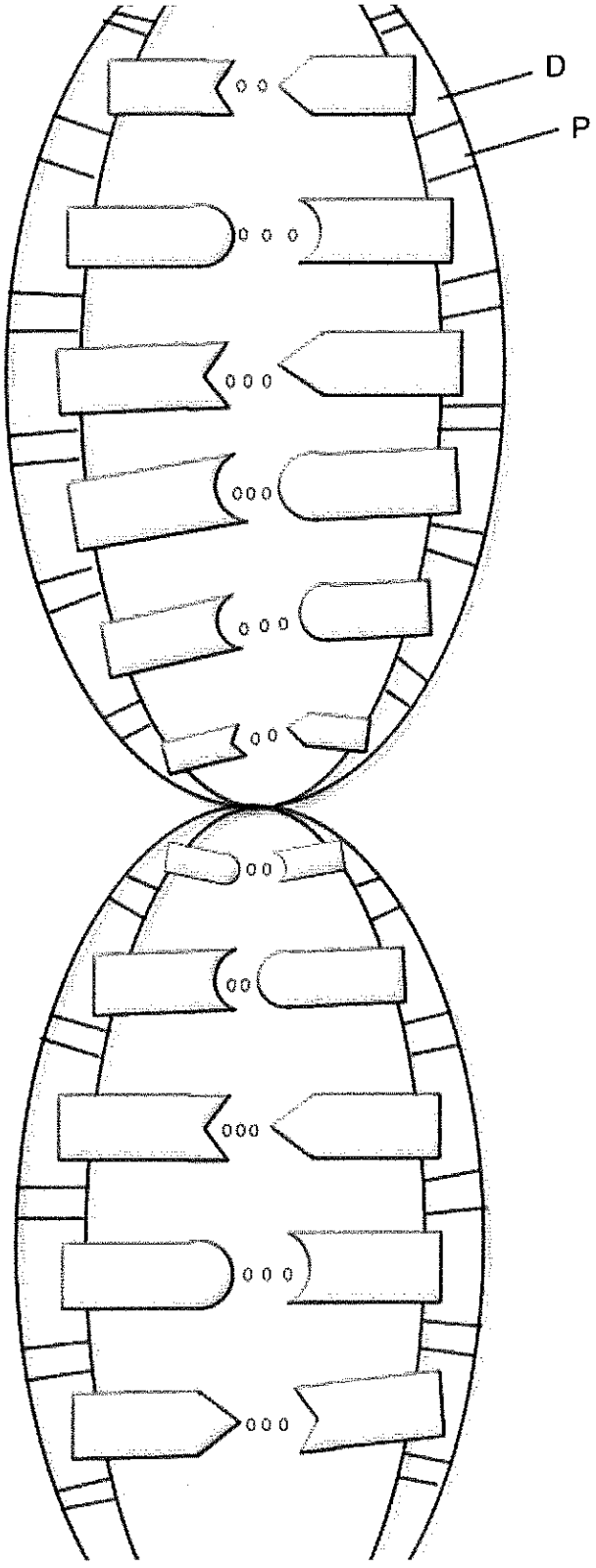
The Blueprint of Life

Every cell in your body has the same "blueprint" or the same DNA. Like the blueprints of a house tell the builders how to construct a house, the DNA "blueprint" tells the cell how to build the organism. Yet, how can a heart be so different from a brain if all the cells contain the same instructions? Although much work remains in genetics, it has become apparent that a cell has the ability to turn off most genes and only work with the genes necessary to do a job. We also know that a lot of DNA apparently is nonsense and codes for nothing. These regions of DNA that do not code for proteins are called "introns", or sometimes "junk DNA". The sections of DNA that do actually code from proteins are called "exons".

Color the images according to your instructions.

Name _____ Score _____/10

DNA -- THE DOUBLE HELIX



1. Write out the full name for DNA. _____

2. What is a gene? _____

3. Where in the cell are chromosomes located? _____

4. What two scientists established the structure of DNA?

   a. _____

   b. _____

5. What is the shape of DNA? _____

6. What are the sides of the DNA ladder made of?

   a. _____

   b. _____

7. What are the "rungs" of the DNA ladder made of?

   a. _____

   b. _____

   c. _____

   d. _____

8. What sugar is found in DNA? _____

9. How do the bases bond together? A bonds with _____ G bonds with _____

10. How do some cells become brain cells and others become skin cells, when the DNA in ALL the cells is exactly the same. In other words, if the instructions are exactly the same, how does one cell become a brain cell and another a skin cell?

11. Why is DNA called the "Blueprint of Life"?

Phenotypes, Genotypes, & Alleles

So far, you have learned quite a bit about genetics, inheritance, and how traits are passed on from parents to offspring. Part of studying the transfer of traits from one generation to the next involves understanding how scientists talk about the traits an organism inherits, as well as how the organism ends up expressing or showing those traits. Today we will explore three of those key terms and how they help us apply concepts of genetics to different situations and predict what traits an offspring can inherit from mom and dad.

We know that offspring inherit traits from their parents through a transfer of DNA in the form of individual genes on each parents' chromosomes. Gregor Mendel and his work with pea plants proved an important fact: this transfer is random. Mom and dad each have two genes for any given trait that they pass on to their offspring; for example, mom has two genes on her chromosome for hair color. However, we know from studying meiosis that the cells mom and dad produce, which will combine to make a zygote (fertilized cell) and develop into the offspring, only contain half a set of chromosomes from each parent. So, while mom has two genes for hair color, she will pass only one of those genes onto the offspring, and the offspring will get their second hair color gene from dad.

Key Idea #1: Mendel's research tells us that *which* of each parent's genes the offspring will end up with for a given trait is *completely random*.

If mom has a gene for brown hair and a gene for red hair, the offspring has a random 50/50 chance of getting one or the other. This is true for every trait that mom and dad can pass on to the offspring!

Brown hair and red hair are two possible hair colors a human offspring could have; blonde hair and black hair are other hair colors humans can inherit as well. Each color is coded for in humans by a specific gene and each color represents different possible forms that the hair color trait could take in a human offspring depending on the genes they inherit from mom and dad. Each of the possible forms of a gene is called an **allele** *(uh-LEE-yull)*.

Remember how the offspring got one of its hair color genes from mom? The specific hair color gene mom gave the offspring (let's say brown hair) represents one allele. This offspring got a brown hair allele from mom. Now let's say dad has alleles for blond hair and red hair on his chromosome. In a random 50/50 split, he passes on the blond hair allele to the offspring. So, our imaginary offspring ended up with one brown hair allele and one blond hair allele for the hair color trait on their chromosomes. If you were a scientist, it would be a huge waste of time to have to go around listing all the alleles in words ("brown hair allele, blond hair allele") for every offspring you are studying. Sometimes scientists are studying a specific trait in hundreds or thousands of people!

Fortunately, we don't have to use words to describe an organism's alleles for a trait. In fact, alleles are usually abbreviated as one single letter. For example, our offspring has brown hair and blond hair alleles. We might abbreviate brown hair as a capital *B* and blond hair as a lowercase *b*, so we could say the offspring's alleles for hair color are *Bb*.
These two combined letters, which represent the two alleles the offspring has for the hair color gene, are called a **genotype** *(JEAN-oh-type)*.

An organism's genotype contains the two alleles for a trait that they inherited from their parents (remember one allele comes from mom and one allele comes from dad). The genotype tells us which two alleles or forms of a trait an organism *could* end up with. The trait the organism eventually displays or shows is called the **phenotype** (*FEEN-oh-type*). Our imaginary organism *could* end up with a phenotype of brown hair, or they *could* end up with a phenotype of blond hair. They *could not* end up with a phenotype of red hair, because the allele for red hair is not in our organism's genotype.

Key Idea #2: The organism's genotype (one allele from mom + one allele from dad for a specific trait) determines the phenotype (what the organism physically displays for that trait).

So how do we find out which phenotype for hair color our imaginary offspring will actually have? We could wait around for the offspring to be born and grow some hair and see what color it is, but that's a bit impractical time-wise. Fortunately, the genotype provides most of the information we need to figure this out. You may have been wondering earlier why a capital B was used for brown hair and a lowercase b was used for blond hair. That wasn't just a random choice- the case (capital or lower) of the letter for an allele shows whether that allele is **dominant** (*DOM-in-ent*) or **recessive** (*re-SESS-iv*) for its trait. For hair color in humans, the allele for brown hair is dominant and the allele for blond hair is recessive. Alleles that are dominant for a trait in a species are represented with *CAPITAL* letters (*B*), while alleles that are recessive for a trait are shown with *lowercase* letters (*b*).

Key Idea #3: In basic genetics, dominant alleles overpower or *cover up* recessive alleles for a trait.

What this means for our offspring is that because they got both a brown hair allele *B* and a blond hair allele *b*, the dominant brown hair allele will *cover up* the recessive blond hair allele, and the organism will have a phenotype of brown hair.

Summary: The offspring got a **dominant** brown hair **allele** *B* from mom and a **recessive** blond hair **allele** *b* from dad. The offspring's **genotype** is *Bb* and the offspring's **phenotype** is brown hair.

A quick note on writing genotypes: If there is a recessive *and* a dominant allele in an organism's genotype, the dominant allele is nearly *always* written first in the genotype. It does not matter which parent gave the allele. We would not write *bB* for the offspring's genotype, we would write *Bb*. You may see this rule broken on occasion during this unit for instructional purposes to help make concepts clearer, but you should always try to remember to write the dominant allele *first* in a genotype and the recessive second. Also, the alleles that make up the genotype for a trait are *always the same letter*. Scientists often use the first letter of the trait being studied or one of the forms of that trait- *B* was chosen because "brown hair" is a trait form for hair color, but *H* could also have been used for "hair color." No matter what letter you pick, just make sure it's the same for both alleles and be sure to differentiate clearly between your capital and lowercase letters when you're writing! Otherwise, things get confusing fast!

The imaginary offspring above ended up with one dominant and one recessive allele for the eye color trait. When an organism inherits two different alleles for a given trait, the organism is **heterozygous** (*het-er-oh-ZYE-gus*) for that trait. *Hetero* is a stem that means "different," and *zygous* comes from "zygote" which refers to the fertilized cell that got half its genes from mom and half its genes from dad and will eventually develop into an organism.

Let's look at another trait in our imaginary offspring - freckles. Mom has freckles and dad doesn't, so the parents aren't sure if their child will end up with freckles or not. However, we can use what we know about genotypes, phenotypes, and alleles to investigate! Through decades of study, scientists have determined for many species whether certain alleles are dominant or recessive for that species' traits. Through this research, we know that in humans the allele for freckles on the skin is dominant, and the allele for freckle-free skin is recessive. We'll use the letter *F* to represent freckles and *f* to represent no freckles.

Mom's genotype for freckles is *Ff*. Dad's genotype for freckles is *ff*. Because the dominant allele (in this case, having freckles) *always* covers up the recessive allele, the only way a human can *not* have freckles is if they end up with two recessive alleles from their parents, like the dad in this example.

During meiosis, mom and dad's chromosomes are randomly divided into their sex cells, and our imaginary offspring is the result of one of those sex cells from mom and one from dad combining to form a zygote. Because we know from Mendel that *which* of the two alleles our offspring gets from a parent for a trait is random, the kid has a 50/50 chance of getting *F* or *f* from mom, and a 50/50 chance of getting *f* or *f* from dad. For the purposes of our example, we'll say our offspring randomly ended up with *f* from mom and *f* from dad. Thus, our offspring's genotype for the freckles trait is *ff*. The offspring is **homozygous** (*ho-mo-ZYE-gus*) for the freckles trait because it received two identical alleles from its parents for this trait. *Homo* is a stem that means "same," and as mentioned earlier, *zygous* comes from "zygote."

An organism that is homozygous for a trait has two matching alleles for that trait. It does not matter whether the alleles are dominant (*FF*) or recessive (*ff*), only that they are the same. Scientists will specify dominant or recessive by adding the appropriate option after "homozygous." In this example, our offspring- and its dad- are **homozygous recessive** for the trait of freckles. Mom, meanwhile, is heterozygous for this trait.

> Key Idea #4: Organisms that are **heterozygous** for a trait have two **different** alleles for that trait. Organisms that are **homozygous** for a trait have two **same** or matching dominant alleles for that trait, either both **dominant** or both **recessive**.

So we know the offspring has a genotype of *ff* for the trait of freckles. Based on what you've read, you should be able to determine what the offspring's phenotype will be for this trait. What do you think it will be?

Practice

Two parents are having a baby. Dad has on an allele for blue eyes and an allele for brown eyes, and mom has two alleles for brown eyes. Blue eyes are recessive in humans, and brown eyes are dominant.

1. Pick a letter to use for the alleles for eye color. (Remember, scientists usually use the first letter of the trait or the first letter of one of the trait forms.)

   Your Answer Here

2. What is mom's genotype?

   Your Answer Here

3. Which option describes mom for this trait? Highlight the correct answer.

   homozygous recessive homozygous dominant heterozygous

4. What is mom's phenotype?

   Your Answer Here

5. What is dad's genotype?

   Your Answer Here

6. Which option describes dad for this trait? Highlight the correct answer.

   homozygous recessive homozygous dominant heterozygous

7. What is dad's phenotype?

   Your Answer Here

8. What are the *only* two possible phenotypes their baby could have? How do you know?

   Your Answer Here

9. What two possible genotypes could the baby have? (Remember baby gets only one allele from each parent, but baby could get *either* of the parent's two alleles at random).

   Your Answer Here

10. Challenge question: What is the *probability* that the baby will be homozygous dominant for eye color? (A fraction, ratio, or percent are fine).

    Your Answer Here

Name: _____ Date: _____ Period: _____

Genetics Practice #1

Snorks are a species of fish on an alien planet. The table below provides information about some of their phenotypes of genotypes.

Characteristic	Dominant Gene	Recessive Gene
Belly Design	Star (S)	No Star (s)
Tail Shape	Smooth (T)	Spiked (t)
Body Color	Purple (B)	Green (b)
Eyes	One (E)	Three (e)

1. Use the information about snorks to write the phenotype for each item.

A. bb _____ B. TT _____

C. tt _____ D. Ee _____

2. Use the information in the chart to write the genotypes for each trait below.

A. Green body color _____ B. Smooth body shape _____

C. Three eyes _____ D. Spiked tail shape _____

3. Determine the genotypes using the information in the chart above.

A. Purebred star belly _____ B. Heterozygous smooth tail _____

C. Homozygous one eye _____ D. Hybrid smooth tail _____

Name: _____ Date: _____ Period: _____

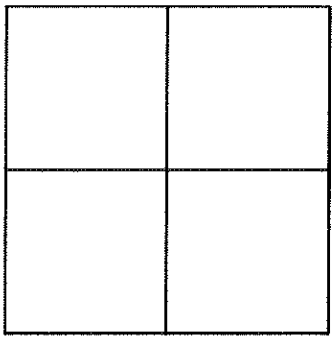
Punnett Square Practice #1

On an alien planet snorks are a type of fish. Some snorks have stars on their bellies while others do not. Use the information provided and your knowledge of heredity to complete the problems below.

1. Write the correct **genotype(s)** for each fish. S represents fish with a star, and s represents fish without a star. (Remember to make you capital and lower case letter VERY different in size!)

   Star: _____ No Star: _____

2. What would happen if a homozygous star-bellied snork and a heterozygous star-bellied snork mated? Complete the Punnett square to determine the chances of each fish offspring.

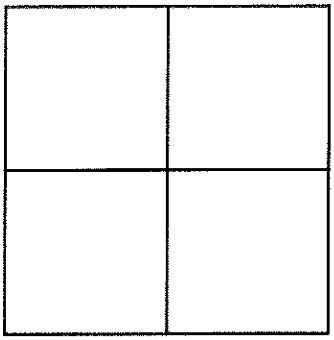


   A. What is the probability the offspring would have a star? _____

   B. What is the probability the offspring would not have a star? _____

3. Mr. and Mrs. Gilfin have just brought home their new baby snork twins from the hospital. However, they are concerned that only one of the twins has a star on her belly. Both Mr. and Mrs. Gilfin have stars on their bellies. Both parents believe they are heterozygous for the trait of star belly. Create a Punnett square to determine whether it is possible for only one of the twins to have a star-belly. (Remember, like people, snork twins don't always look identical.)

   Is it possible? Explain.



Name: _____ Date: _____ Period: _____

Punnett Square Practice #2

Snorks are a species of fish from an alien planet. The table below provides information about some of their phenotypes of genotypes.

Characteristic	Dominant Gene	Recessive Gene
Belly Design	Star (S)	No Star (s)
Tail Shape	Smooth (T)	Spiked (t)
Body Color	Purple (B)	Green (b)
Eyes	One (E)	Three (e)

1. Use the information about snorks to write the phenotype for each item.

A. Ss _____ B. tt _____

C. EE _____ D. Ee _____

2. Use the information in the chart to write the genotypes for each trait below.

A. Purple body color _____ B. Green body color _____

C. One eye _____ D. Spiked tail shape _____

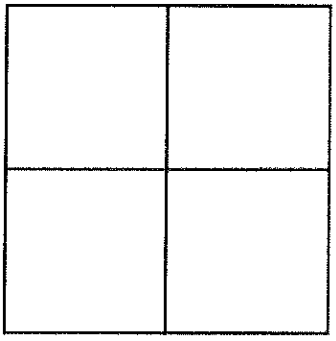
3. Determine the genotypes using the information in the chart above.

A. Purebred smooth tail _____ B. Heterozygous star belly _____

C. Homozygous purple body color_____ D. Hybrid smooth tail_____

4. Bobble, a star bellied snork, recently married Gilda, another star bellied snork. The happy couple is already expecting their first baby snork. The couple knows a thing or two about genetics and is trying to figure out if it is possible for them to have a baby snork without a star on her belly. Before they can figure that out they need to determine their own genotypes. Complete the steps below to help them figure out if their baby snork can be born without a star.

   A. Bobble's mother and father brag that their bloodline is pure and that no one in their family has ever been born without a star. As Bobble's mother says, "We are all shining stars!". Fill in the Punnett square to answer questions below.

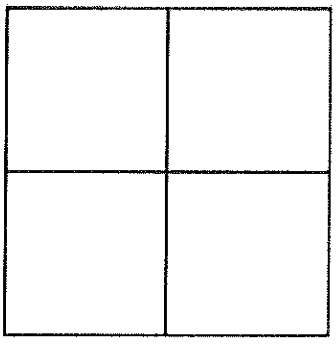


   I. Bobble's mother's genotype _____

   II. Bobble's father's genotype _____

   III. Bobble's genotype _____

   B. Gilda's mother has a star on her belly, but her father does not have a star on his belly. Since all 12 of Gilda's siblings have stars on their bellies they assumed that Gilda's mother is homozygous for her star belly trait. Fill in the Punnett square to answer the questions below.



   I. Gilda's mother's genotype _____

   II. Gilda's father's genotype _____

   III. Gilda's genotype _____

   C. Now that Bobble and Gilda know their own genotypes, help them figure out if their baby can be born without a star. Use the Punnett square to help you determine the answer.

   Can their baby be born without a star?