The Chemical Company

Kids' Lab
Creating Fun with Chemistry!

**Experiment Guide**

# Genetic Code Key Chains

## Objective

Students will create key chains showing the DNA sequence that represents their name. They will convert the letters of their name into amino acids and then into the equivalent DNA sequences.

## Introduction to Kids' Lab

Welcome to the BASF Kids' Lab. BASF is the world's largest chemical company and run Kids' Lab programs like this all around the world. Can anyone think why? BASF wants children all over the world to understand and enjoy experimenting with chemistry!

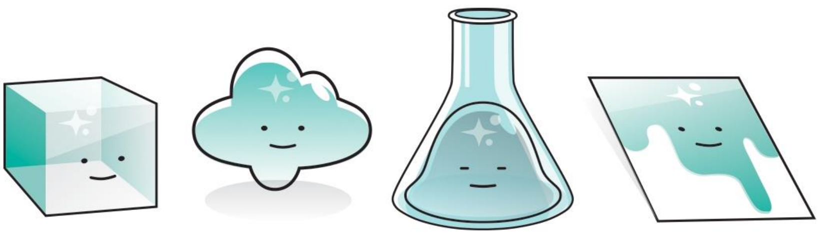
Has anyone heard that word before: Chemistry? What do you think it means?

**Chemistry is the science of matter.** Have you heard the word "matter" before? What is matter? Matter is anything that takes up space and has a weight here on earth. So basically, matter is a scientific word for stuff.
Chemistry is a science that explores the composition of substances and their properties and reactions. In other words, Chemistry is a science that explores how different stuff behaves.

Matter comes in a few different forms or states: Solids, Liquids and Gases are the most common.

Chemistry is all around us. For example:
Who takes a vitamin? How do vitamins help you? (Grow big and strong boost immunity)
BASF makes chemicals that go into vitamins.
Raise your hand if you play a sport or ride a bike.
What should you do to be safe? (Wear a helmet, pads, etc.) What materials make up the helmets that you wear? (Plastics and foam)
BASF makes chemicals that go into the plastics and foams in helmets and
padding.
Besides helping you grow strong and keeping you safe when you are playing your favorite sport, BASF chemistry keeps farmers crops safe, cleans water for those in need and keeps babies clean and dry.

Let me introduce you to morpH, the face of Kids' Lab. morpH can move through the three states of matter with ease.Is there a substance that you know of, like morph that can easily shift from solid to liquid to gas (and back again)? Water! That's right! You know that water is usually liquid but what happens when you freeze water? Water becomes a solid ice cube. When you boil water, it becomes a gas. Water is one of the most important substances on earth.Not only does water make life possible, but it can be used to create beautiful works of art.



**morpH and I would like you to explore Restriction Enzymes.**

**Experiment Introduction:**

**DNA** is a chemical code found in all living things and is necessary for us to develop and function. This code is made up of combinations of 4 letters known as bases. The bases are Adenine (A), Cytosine (C), Guanine (G), and Thymine (T). DNA is a double-stranded molecule. It is more difficult to break this critical molecule, since it has increased stability with the second strand. The two strands also allow for copying and preservation of the information contained within the molecule. It is ideal to store and transmit genetic information. The base pairing rule is: A always pairs with T and C always pairs with G. The direction that that the code is read in is called the foward strand while the reverse strand is the matching base pairs. The backbone of the DNA molecule is made up of a sugar and a phosphate molecule. These molecules are the same regardless of the base at each location.

DNA is converted into protein which is the functional part of our living cells. Proteins are another chemical code made up of 20 amino acids. Combinations of the 20 amino acids make up all the different proteins in your body which have many functions. Can you think of some of the proteins that make up your body? Keratin makes up hair, fingernails, and skin. Think about the different textures and functions of those body parts. Fingernails are hard and rigid while skin is soft and flexible. Proteins known as enzymes help to speed up chemical reactions such as breaking down of food. Protein also makes up a part of your immune system to help fight off illness. These are just some examples of the many functions of protein within the human body. The increased number of amino acids allows for this diversity of function.

So how can you convert from a 4 letter base code found in DNA to a 20 amino acid code found in protein?

The DNA code is read in three letter blocks called **codons**. Each three letter combination of A, T, C, G within a codon determines which amino acid is at that location within the protein. Each amino acid has a name and a 1 letter designation. Some amino acids are represented by multiple codons. Each amino acid has a letter code; however, there are more letters in the alphabet than amino acids. For this activity, we will use stop codons for those letters that do not correspond to an amino acid. Stop codons within DNA do not transmit any information but are necessary for determining the length of genes.

Make sure you are familiar with the following terms:

**DNA:** Deoxyribonucleic acid; chemical code made up of bases found in all living things that contains all the genes

**Bases:** Adenine (A), Cytosine (C), Guanine (G), Thymine (T), letters which make up DNA

**Protein:** Chemical code made up of amino acids found in all living things; translates the code found in DNA into functional

**Codons:** Grouping of three DNA bases that make up each amino acid

**Forward strand:** Direction in which the chemical code is read from left to right

**Reverse strand:** Base pairs that match the forward strand using the following rules: A matches with T; G matches with C

**Activity: Can you convert the letters in your name into amino acids and the corresponding codons? Then you can spell your name in "DNA".**

But first,

***Lab safety is a must!*** In order to safely explore Chemistry, we need to follow proper lab safety. How do you think we are going to do this? Chemists follow very strict procedures to protect themselves and they include:

- Gloves
- Goggles
- Lab aprons
- Point out any safety features in the classroom (ie. Eyewash or emergency shower)
- Mention housekeeping rules – NO EATING OR DRINKING

In our case, please put on your safety glasses. Be careful handling the wire for stringing the key chains.

**The Experiment:**

**Materials required:** Wire, Beads (number dependent on name; 4 different colors)

**Procedure:**

1. Write out your name in the below box.

| Your name | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Forward strand | | | | | | | | | | |
| Reverse strand | | | | | | | | | | |

1. Select a codon from the below table that corresponds to each letter in your name. Write the base sequence that makes up that codon in the "Forward Strand" box.
2. Create your reverse strand. Don't forget that A always pairs with T and G always pairs with C.
3. Count the number of A, T, C, G you need to make the key chain that codes for your name. Each base gets a different color, so pick out the correct number of beads of each color. You will also need a sugar and a phosphate bead for each base and a phosphate bead.
4. String the sugar molecules and the first base pair on first. For the next base pair, string the sugar, phosphate, and forward strand base on one wire. String the sugar, phosphate, and reverse strand base on the other wire. Loop the wire from one side through the phosphate and base on the other strand. Repeat on the other wire.
5. String the remaining beads on using the steps detailed in step 5 until you have finished your name.

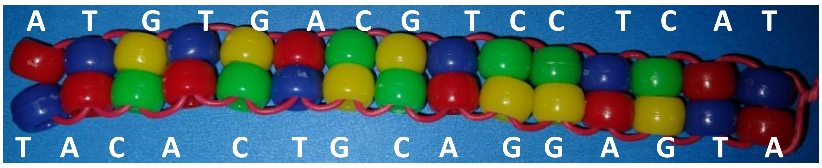
| Base | A | T | C | G |
|---|---|---|---|---|
| Number needed | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alanine | | Cysteine | Aspartic acid | Glutamicacid | Phenylalanine | Glycine | Histidine | Isoleucine | | Lysine | Leucine | Methionine | Asparagine | | Proline | Glutamine | Arginine | Serine | Threonine | | Valine | Tryptophan | | Tyrosine | |
| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
| GCT<br>GCC<br>GCA<br>GCG | TAA | TGC<br>TGT | GAT<br>GAC | GAG<br>GAA | TTT<br>TTC | GGT<br>GGC<br>GGA<br>GGG | CAT<br>CAC | ATT<br>ATC<br>ATA | TAG | AAA<br>AAG | TTA<br>TTG<br>CTT<br>CTC<br>CTA<br>CTG | ATG | AAT<br>AAC | TGA | CCT<br>CCC<br>CCA<br>CCG | CAA<br>CAG | CGT<br>CGC<br>CGA<br>CGG<br>AGA<br>AGG | AGT<br>AGC<br>TCT<br>TCC<br>TCA<br>TCG | ACT<br>ACC<br>ACA<br>ACG | TAA | GTT<br>GTC<br>GTA<br>GTG | TGG | TAG | TAT<br>TAC | TGA |

Let's use morpH as an example!

| Your name | M | O | R | P | H |
|---|---|---|---|---|---|
| Forward strand | ATG | TGA | CGT | CCT | CAT |
| Reverse strand | TAC | ACT | GCA | GGA | GTA |

| Base | A | T | C | G |
|---|---|---|---|---|
| Number Needed | 8 | 8 | 7 | 7 |




**BASF, DNA, and Proteins:**
We are always looking for interesting proteins to help us create chemistry. For example, we use proteases (a type of protein enzyme) to break down stains in our laundry detergents. We also use different proteins in our hair care products like shampoos and conditioners to help people have their best hair day! We look for proteins that do a desired job and then can use the amino acid sequence to figure out the DNA sequence. Just like you just did!