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GENES & PROTEINS

Most people know that a gene gives us and all living organisms certain characteristics, such as blue eyes or susceptibility to certain diseases. We inherit our genes from both of our parents. This is the same for all living organisms. All this information which governs life is stored in a molecule called Deoxyribonucleic Acid (DNA). But, on a molecular level how does your DNA determine your observed characteristics? It comes down to understanding what DNA is made of and what proteins are. Let's look at both.

GENES

The term gene is derived from the Greek word *gena*, meaning birth or descent. On a molecular level, a gene is part of the DNA, and sometimes called a unit of DNA. DNA is a molecule made from sugar, phosphate and four bases called guanine, cytosine, adenine and thymine. They are abbreviated G,C,A, and T respectively. These bases make up the DNA in plants, animals, bacteria, yeast, fungi and some viruses. However, the sequence of bases varies among different individuals and different organisms.

Imagine if these bases were blocks, how many different ways you could place them in line. For example you could have AAGCT, CCAGT, or TACGGT and many other combinations. Different genes have different sequences of bases and different lengths and so you could end up with an infinite variety of combinations. The order of these bases is sometimes referred to as the "genetic code" as their sequence encodes information.

This code is "translated" into a protein. The combination of different genes in an organism determines the composition of the proteins in its cells, accounting for the diversity seen in different life forms.

DNA DECODER

AminoAcid	DNA Sequence Triplets					
Alanine	GCT	GCC	GCA	GCG		
Arginine	AGA	AGG	CGA	CGC	CGG	CGT
Asparagine	AAT	AAC				
Aspartic Acid	GAC	GAT				
Cysteine	TGC	TGT				
Glutamic Acid	GAA	GAG				
Glutamine	CAA	CAG				
Glycine	GGA	GGC	GGG	GGT		
Histidine	CAC	CAT				
Isoleucine	ATT	ATC	ATA			
Leucine	TTA	TTG	CTT	CTC	CTA	CTG
Lysine	AAA	AAG				
Methionine	ATG					
Phenylalanine	TTT	TTC				
Proline	CCT	CCC	CCA	CCG		
Serine	AGC	AGT	TCT	TCC	TCA	TCG
Threonine	ACT	ACC	ACA	ACG		
Tryptophan	TGG					
Tyrosine	TAC	TAT				
Valine	GTT	GTC	GTA	GTG		

Proteins

When we think of protein we usually think of dietary protein, but proteins carry out a variety of functions including enzymes which catalyze chemical reactions. Other proteins are signal messages between cells such as protein hormones. Some proteins, such as antibodies, are part of the immune system, other proteins form structures in the cells, and other proteins act as channels allowing things to pass in and out of cells. The human body has over 30,000 types of proteins. Some of these proteins will be the same, or similar in other organisms; some will be different.

Despite the variety of functions that proteins serve, all proteins are made up of various combinations of units called amino acids. There are 20 amino acids encoded by DNA, including arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine, tryptophan, tyrosine and valine. These amino acids can be found in several different orders and in different lengths to form a characteristic protein.

Each amino acid also has a unique character that is determined by size, charge, and by hydrophobicity. A hydrophobic molecule is one that does not dissolve readily in water, but will dissolve in oil. At the other end of the spectrum is hydrophilic molecules which dissolve in water, but not in oil.

The structure of the protein determines the function of the protein. In other words, it determines what the protein does.

From Gene to Protein

A cell's machinery reads a gene three base letters at a time, e.g. AAC GTT CGT, creating a message that then "translates" these three bases into an amino acid. See the DNA decoder on page 1. All living organisms "translate" DNA using the same decoder.

Let's suppose that you were to change the DNA sequence of a living organism, or to "mutate" the DNA. For example lets take the gene AAC GTT CGT. This would result in a chain of amino acids that would be Asparagine-Valine-Arginine.

If you were to change the gene to AAC GAT CGT, then the gene would become Asparagine-Aspartic Acid-Arginine, and the function of the protein could change.

How could you use this information? Biotechnology uses this knowledge of how genes and proteins work to:

- Change the DNA sequence to make a different protein. Some inherited diseases, for example, are caused by a single base change.
- Transfer the gene sequence that codes for a particular beneficial protein. This would result in the production of a new protein. This process is called genetic engineering.
- Block a piece of DNA that makes a harmful protein. This process is called antisense therapy.

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