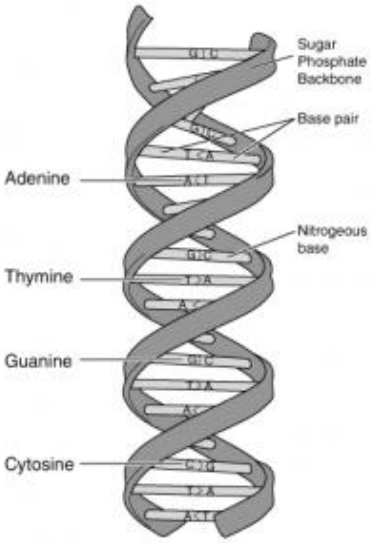
What is DNA?

Understand the relationship of the structure and function of DNA to protein synthesis and the characteristics of an organism.

DNA

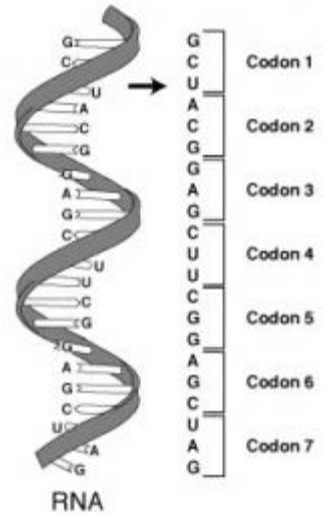
"It's in your genes!"

Structure of DNA



Have you ever been told that you look just like your mother, or that you act just like your brother or sister? You may not think it's true, but there's a good reason that people say that. It's because, in every cell in your body, you have (more or less) the same DNA. As you already know, you get one copy of your DNA from your mother and one from your father. Also, you know that the DNA is split up into strands called chromosomes, and that the ribosomes use the DNA in order to make proteins.

RNA is made up of codons

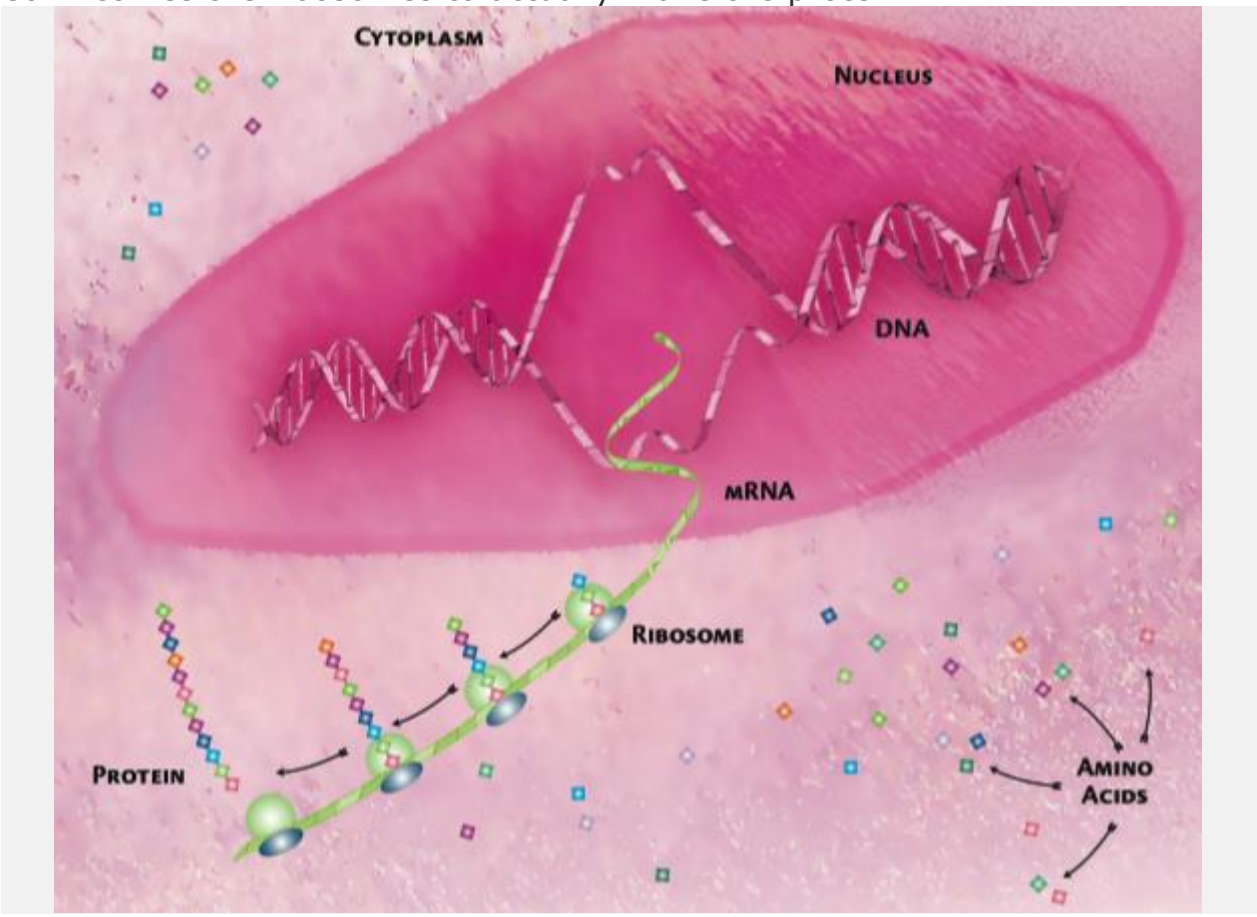


But what does it really mean that this DNA is in every single one of your cells? After considering this for a while, many people ask themselves things like, "Why do the cells in my heart need to have the same information as the cells in my stomach?" It's true that all of the 100 trillion cells in your body have all of the genetic information to be or do anything that your body does. It's also true that your DNA is 3 billion "letters" long; in other words each one of those 100 trillion cells contains 3 billion pieces of information!

Each cell in your body only uses the information that it needs from the DNA; in other words, your heart cells only use the

heart information, the stomach cells the stomach information. But the cells carry everything around in case they need to become something else, a power which scientists are just beginning to use themselves!

So, how does that DNA actually *do* anything? The trick is that DNA is turned into proteins, and it's the proteins that make a heart cell beat, a nerve cell send messages, and a lung cell take up air. You can think of the relationship between DNA and protein like this: the DNA is like a page of instructions to build a house and the proteins are the wood, steel, nails, screws and glass that actually make up the house. Clearly, to get from the instructions (DNA) to the building materials (proteins), something needs to put it all together – so in comes the ribosomes to actually make the protein!

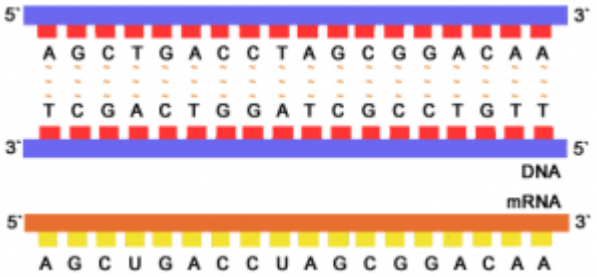


An overview of how DNA becomes proteins

The instructions contained in DNA are made up of only four bases: the chemicals **adenosine** (A), **thymine**(T), **cytosine** (C) and **guanine** (G). Each base (or "letter") has a pair: every A is paired with a T, every T with an A, every C with a G, and every G with a C. Different combinations of these

chemicals make "words", otherwise known as **codons**. Codons are made up of three letters in a row: ATG, GCC, ATC, etc. Ribosomes look at each codon and grab a different **amino acid**. The ribosomes keep adding amino acids until they get to the end of a **gene**. The string of amino acids that has been made is called a **protein**.

There is one step in the diagram which has not been mentioned yet. You may have already noticed that the DNA stays in the nucleus but the ribosomes stay outside the nucleus. So, how is it that the ribosomes make proteins from the DNA? There is a messenger that takes the instructions from the nucleus to the ribosomes: it's called **messenger RNA** (mRNA). As in our example from before, the instructions are contained in the DNA and the actual building materials are the proteins. Often, just like building a house, the instructions cannot be read by simply anyone. It's the job of the mRNA to put the bases into a language that the ribosomes can understand, which is called **transcription**.



Transcription of DNA into mRNA

RNA, as we saw with viruses, is very similar to DNA. There is one major difference: where DNA has thiamine (T), RNA has uracil (U). This means that, if a DNA codon reads "ATA", then the same codon in RNA will be "AUA".

In summary, DNA contains the instructions in sets called genes. One gene is converted to mRNA, which goes outside the nucleus of the cell. Outside of the nucleus, the ribosomes read the mRNA, attaching one amino acid for every three base pairs (codon). This sequence of amino acids is a protein. For every gene of DNA, there is one and exactly one protein.

Questions

1. What are the four bases in DNA? What are they in RNA?

2. What takes the instructions in DNA from the nucleus to the ribosomes?

3. What is a gene?

4. Write the complementary strand of DNA: CTACGCCATATTCGGCGATAC

How many codons does the original stand have?

5. What RNA sequence would result from transcription of the DNA sequence: CTACGCCATATTCGGCGATAC