Dna structure: dna replication rna synthesis protein

DNA, or deoxyribonucleic acid, is the genetic material of a cell. It contains information about an organism's cell structure, function, development and reproduction. DNA must be able to replicate quickly and correctly so that the daughter cells have the same genetic information as the parental cell. DNA must also be capable of change. This provides variation among different generations and was the key factor for evolution to occur. DNA is a polymer (made up of many units) of nucleotides. Each nucleotide contains a five-carbon sugar (there is an extra hydroxyl group in the sugar for RNA), a nitrogenous base, and a phosphate group. There are two classes of nitrogenous bases, purines and pyrimidines. Each purine pairs up with one pyrimidine. Adenine and guanine are purines (double ring structures), while cytosine, thymine (DNA), and uracil (RNA) are pyrimidines (single ring structures). Nucleotides are linked together by a covalent bond between the phosphate group of one nucleotide and the 3'carbon of the sugar of another nucleotide. These 5′-3′ linkages are called phosphodiester bonds. These bonds are very strong and provide a good backbone for the structure of DNA. Experiments were done by Watson and Crick, and Franklin and Wilkins provided a three-dimensional model of DNA- the double helix. It is composed of 2 chains that are anti-parallel to one another (rope ladder that is twisted). Each " step" of the ladder is composed of one purine, ad one pyrimidine (adenineƒ thymine, guanineƒ cytosine). The central dogma of biology is DNAƒ RNAƒ protein. DNA, which contains the genes that are expressed, has to be transcribed and translated first. DNA is transcribed into mRNA, which codes for a specific protein and is assembled through ribosomes. Proteins are synthesised by amino acids. The order of nucleotides in DNA determines the amino acids used in synthesising a protein. Three nucleotides (codon) code for one amino acid; there are 64 different possibilities of codons. There is a total of 20 amino acids, which means that more than one codon codes for the same amino acid. There are also “ start” codons to begin protein synthesis and “ stop” codons to terminate protein synthesis (Russell, 9-19).

Hypothesis:

- I predict that we will be able to understand the structure of DNA and RNA after this experiment.
- I predict that I will achieve a better understanding of protein synthesis after this experiment.

Methods:

1. We obtained 60 white beads (deoxyribose sugar), 60 red beads (phosphate group), 15 orange beads (adenine), 15 green beads (guanine), 15 blue beads (cytosine), 15 yellow beads (thymine), and 30 clear connectors (hydrogen bonds).
2. We assembled 60 nucleotides by attaching a red bead (phosphate group) to the white bead (deoxyribose sugar) in a 5′ position.
3. We attached a nitrogenous base bead (orange/green/blue/yellow) to the 1′ position of the deoxyribose sugar (white bead)
4. We constructed a single-stranded polynucleotide chain by attaching the phosphate group of one nucleotide to the 3′ end of another deoxyribose sugar (this strand contained 30 nucleotides- remember to add the nitrogenous bases in a random order).
5. To form the typical double stranded DNA molecule, an antiparallel single strand must now be constructed to bond with the initial strand.

6. The remaining 30 nucleotides were attached in the same manner as mentioned above.
7. They were placed antiparallel to the other strand, but we made sure that the nitrogenous bases across each strand were complementary (A bonded with T, and G bonded with C).
8. Connectors were placed between the bases to represent hydrogen bonds.
9. We then simulated DNA replication by first forming an origin of replication. Beads were obtained and attached in a 5'ƒ 3′ direction. 2 DNAs were synthesised (each with one parental strand and one new complementary strand), which showed the semiconservative model.
10. We then simulated RNA synthesis (transcription).
11. We obtained 24 pink beads (ribose sugar), 24 red beads (phosphate group), 6 orange beads (adenine), 6 green beads (guanine), 6 blue beads (cytosine), and 6 purple beads (uracil). We also obtained a template DNA strand.
12. We constructed the RNA nucleotides in a similar fashion that we made the DNA nucleotides.
13. We followed the DNA strand and attached the RNA nucleotides accordingly (complementary to the template strand of the DNA).
14. We then simulated protein synthesis by encoding the mRNA (translation).
15. We positioned the RNA horizontally in a 5'ƒ 3′ fashion and uncoded the RNA. 3 nitrogenous bases make up one codon. We wrote down the different codons and using a table, figured out the amino acids required to make the protein.

16. Lastly, we constructed the polypeptide by connecting the different amino acids. The chain kept building as the chain moved from the A site to the P site to the E site.

Results:

- DNA Strand- 5′-ATGGCTAGTATAGGTTGCCATCGATGGCAG-3′
- 3′-TACCGATCATATCCAACGGTAGCTACCGTC-5′
- RNA Strand- 5′- AUG-GUC-UAC-CUA-ACG-CCG-GAU-UAG-3′
- Coding for- f-Met-Val-Tyr- Leu-Thr-Pro-Asp-termination

Conclusion:

DNA is very important for life. It can replicate well, which means that the next generation will retain the characteristics of the parents. It is capable of change, which means that it provides for variation and was crucial for evolution to occur. It also codes for proteins that help express genes and traits of the organism.

In this lab, we simulated DNA structure, replication, RNA synthesis and protein synthesis. Each one of these processes is essential to human life and a mutation in any one of the processes could lead to death. In DNA, adenine bonds to thymine via two hydrogen bonds, while guanine bonds to cytosine via three hydrogen bonds. In all DNA, the amount of adenine should equal the amount of thymine, and the amount of guanine should equal the amount of cytosine (1: 1 ratio of A: T and G: C). However, the differentiation in the ratio of the adenine/thymine pair to guanine/cytosine pair varies greatly among organisms. DNA replicates semi-conservatively. This means that during replication, the strands separate, replication occurs and when the two daughter DNAs are formed, each one contains one parental strand and one new strand.

Lastly, in this simulation, we did not have post-transcriptional editing where introns are excised. Each gene codes for a polypeptide which could have various function depending on the amino acids that synthesised it. This experiment was very helpful in the sense that it helped us realise how complex the processes of replication, transcription and translation are.