Structure Of DNA

DNA is the polymer of nucleotides.

Nucleotides

Nucleotides are monomers that join together to form nucleic acid (DNA and RNA).
It consists of:

1. Nucleic acid
2. Phosphate group
3. Pentose sugar

RNA consists of ribose as pentose sugar while DNA consists of deoxyribose sugar as a base.

Role Of Nucleotides

1. They form polymers of DNA and RNA which play a role in inheritance.

2. A phosphorylated nucleotide contains phosphate bonds that serve as an energy carrier. Like ATP. They have three phosphate groups attached which serve as high energy bonds.

3. They serve as a coenzyme for different metabolic reactions. E.g. NAD.

Types Of Nucleotides

There are four different types of nucleotides. It depends upon the types of nitrogenous bases. There are four different types of nitrogenous bases.

1. Adenine =A
2. Guanine =G
3. Thymine =T
4. Cytosine =C

They are represented by the first letter they contain.

A and G are purine bases. They contain a double-ring structure.

Cytosine and Thymine are pyrimidine bases. They have a single-ring structure.

Nucleotides are joined together by condensation to form polymers. The phosphate group of one nucleotide is bonded with the pentose sugar of others.

Structure Of DNA And RNA

RNA

1. RNA has a single-stranded structure. The strands can coil upon each other.

DNA

1. DNA consists of a double-helical structure that is two strands that run opposite to each other and twisted around each other.

2. There are hydrogen bonds between the nitrogenous bases on two strands.

3. Adenine bonds with thymine and Guanine bonds with cytosine.

Significance Of Complementary Base Pairing:

1. Only certain bonding is possible. That is Adenine can only bond with thymine and Cytosine always bond with Guanine.

2. The two strands are complementary to each other. That means if one strand is broken the other can be figured out easily.

3. The DNA replication is semi-conservative that is each daughter cell has one strand from the parent.

4. Complementary base pairing results in the formation of identical daughter DNA.

DNA Replication

Before cell division, the cell needs to double up its DNA. This is important so that each daughter cell form has an equal amount of DNA.

During the S phase of interphase, the cell replicates its DNA.

Semi-Conservative Replication:

- The hydrogen bonds between two strands breaks and the two

strands are unzipped.

- Nucleotide bases moving freely in the cytoplasm bumps with the opened strand.
- Adenine binds with Thymine and Guanine pairs with Cytosine.
- DNA polymerase joins the deoxyribose part and phosphate part of nucleotides.
- The replication is called semiconservative because each daughter's DNA contains a half strand of the parent DNA.

Protein Synthesis

DNA contains a series of nitrogenous bases. These nitrogenous bases code the sequence of amino acids that are to be linked together to form a particular protein.

This series of nitrogenous bases is called a gene.

Thus, DNA contains genes. One gene codes for one protein.

Three nitrogenous bases code one amino acid. They are called codons. They code the primary structure of the protein which folds to form its tertiary structure. This tertiary structure is important for the function of proteins which serve as enzymes for different metabolic reactions.

For example:

There are 20 different types of amino acids.

As there are only 4 bases, 43=64. Thus, there are 64 possible pairings of the nitrogenous base. Amino acids are coded by more than one triplet.

For example AAA and AAG both code for phenylalanine.

Mechanism Of Protein Synthesis

Proteins are synthesized in the cytosol by ribosomes. The whole process is divided into two steps:

Transcription

• To make protein the copy of genetic code is to be sent to the ribosomes in the form of mRNA this process is called transcription.

Process

• The DNA is unzipped to expose nitrogenous bases.

There are four nucleotides in the cytoplasm(A, U, T, C). They attach with their complementary

• DNA bases.

• The pairing takes place in the following order:

AàU

CàG

GàC

TàA

• When the RNA nucleotides are attached with their complementary bases RNA polymerase binds them together. The RNA nucleotides linked together are called messenger RNA. Messenger RNA contains a copy of genetic code which can then be transferred to the ribosomes for making proteins.

Translation

The making of protein from messenger RNA is called translation.

• The mRNA formed breaks from the nucleus and is moved to the cytoplasm.

• The cytoplasm has 20 different amino acids and tRNA.

• tRNA is a type of RNA. It consists of an exposed nitrogenous base on one side and amino acid is attached to its other side. The nitrogenous base on tRNA is called an anticodon. The amino acid attached to tRNA is complementary to the anticodon. For example, tRNA with anticodon UAC will have methionine attached to it.

• mRNA will be attached to the ribosome. The first two codons will be attached to the groove in the ribosome. tRNA will bring the anticodon that is complementary to the codon. The amino acids

that are attached to the adjacent tRNA will form a peptide bond. mRNA will move within the ribosome bringing in the next codon.

• The first codon is always a start codon that is AUG. it codes for methionine.

• This process will continue until a stop codon is reached.

• A stop codon, for example, UAG does not code any amino acid. Thus, the process of translation is terminated over here.

Gene Mutation

Any abnormal change in the DNA is called a mutation.

These mutations or changes can arise anywhere in the DNA. The cell contains various repair mechanisms thus most of the time these mutations are repaired. But, there are times when they persist. This results in a change in the expression of the gene.

Types Of Mutation

Different types of mutations arise in DNA

Deletion

• A pair of nitrogenous bases can get deleted in a gene.

Insertion

• Nitrogenous bases can be added in genes.

Translocation

• A portion of one chromosome can be translocation to another chromosome making a fusion gene.

Inversion

The sequence of nitrogenous bases is inverted to create a mirror image of the gene.

Result Of Mutations

The change in the sequence of nitrogenous bases results in the formation of an abnormal protein. This is because the sequence of amino acids is changed resulting in a change in the structure of the protein. As the structure is linked to its function thus most of the proteins cannot perform their function.

Sickle Cell Disease

Haemoglobin contains 4 chains of proteins linked together. There are two alpha-globin and two beta-globin as previously said.

In sickle cell disease, there is a mutation in the Beta globin. There is a change in only one base that is it contains T in place of A.

This results in the substitution of valine in place of glutamic acid in the beta chain. The resulting haemoglobin is called HbS.

Normal Hb is called HbA.

Effect Of Mutation

Glutamic acid is hydrophilic it interacts with the aquatic environment to make the Hb molecule stable.

Valine is hydrophobic. Thus, it is insoluble and makes ppts of haemoglobin.

In the case of hypoxia, the HbS stick to each other and make long insoluble fibres. These fibres distort the shape of haemoglobin and make it Sickle-shaped. This sickle-shaped haemoglobin is rigid and cannot pass through small capillaries. This results in hemolysis.