DNA Structure & Replication

Structure of DNA

- Each DNA nucleotide is made up of 5-carbon sugar called deoxyribose, a phosphate group, and a nitrogenous base.
- DNA uses bases A, C, G, & T. (RNA uses A, C, G, & U)

Double Helix

- DNA has an antiparallel structure→ The 2 strands run in opposite directions of eachother.
- Each strand has a 5' end and a 3' end.

DNA Replication

- DNA is *Semi-Conservative*

→Each of the 2 strands in DNA acts as a template to produce 2 new strands.

- Enzymes "unzip" DNA molecules by breaking the hydrogen bonds that hold the two strands together.
- Primary enzyme involved is *DNA polymerase*

→ Joins nucleotides to synthesize the new complementary strand.

→Proofreads each DNA strand to prevent errors.

Leading & Lagging Strand

- *Leading Strand*

→runs 5' to 3' towards the fork and is made continuously.

DNA Structure & Replication (cont)

- *Lagging Strand*

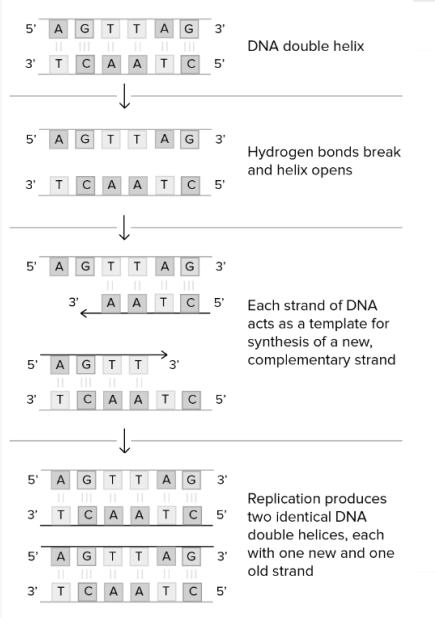
→runs 5' to 3' away from the fork and is made in small pieces called Okazaki fragments.

Other Things to Know:

DNA polymerase only synthesizes DNA in the 5’ to 3’ direction only. The difference between the leading and lagging strands is that the leading strand is formed towards replication fork, while the lagging strand is formed away from replication fork.

DNA replication is not the same as cell division. Replication occurs before cell division, during the S phase of the cell cycle. However, replication only concerns the production of new DNA strands, not of new cells.

Replication



Mutations

point mutation	affects 1 nucleotide pair
1. silent mutations	do not change amino acid translation
2.missense mutations	a single nucleotide change results in a codon that codes for a different amino acid
3. nonsense mutation	a regular amino acid codon is changed into a stop codon, ending translation
insertion or deletion	addition/loss of nucleotide pairs
1. frame shift mutation	deletion or insertion in a DNA sequence that shifts the way the sequence is read
mutagens	forces that interact with DNA in ways that cause mutation *example: xrays*

Transcription

Transcription Key Points

- Involves copying a gene's DNA sequence to make an RNA molecule.
- Performed by RNA polymerase
- 3 Stages: Initiation, Elongation, Termination.
- RNA molecules are spliced and have a 5' cap and poly-A tail put on their ends. (Eukaryotes) }

Initiation, Elongation, Termination

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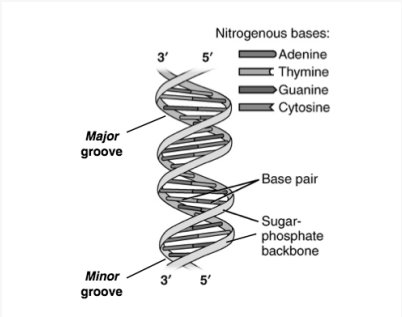
Transcription (cont)

RNA polymerase binds to a sequence of DNA called the promoter, found near the beginning of a gene. Each gene (or group of co-transcribed genes, in bacteria) has its own promoter. Once bound, RNA polymerase separates the DNA strands, providing the single-stranded template needed for transcription.

One strand of DNA, the template strand, acts as a template for RNA polymerase. As it "reads" this template one base at a time, the polymerase builds an RNA molecule out of complementary nucleotides, making a chain that grows from 5' to 3'. The RNA transcript carries the same information as the non-template (coding) strand of DNA, but it contains the base uracil (U) instead of thymine (T).

Sequences called terminators signal that the RNA transcript is complete. Once they are transcribed, they cause the transcript to be released from the RNA polymerase. An example of a termination mechanism involving formation of a hairpin in the RNA is shown below.

DNA



Terms

DNA	Nucleic acid that transmits genetic information from parent to offspring and codes for the production of proteins
Nucleotide	Building block of nucleic acids
Double Helix	Structure of two strands, intertwining around an axis like a twisted ladder
DNA replication	Process during which a double-stranded DNA molecule is copied to produce two identical DNA molecules
Base Pairing	Principle in which the nitrogenous bases of the DNA molecules bond with one another (AT, CG))

DNA vs. RNA

DNA	RNA
Double Stranded, Anti-parallel	Single Stranded
A+T and C+G	A+U and C+G
Mostly Found in Nucleus	Mostly Found in Cytoplasm
Deoxyribose	Ribose
Long Polymer	Much Shorter
Forms Double Helix Structure	Forms Secondary or Tertiary Structure

Translation

Translation

tRNAs are molecular "bridges" that connect mRNA codons to the amino acids they encode.

One end has an anticodon, which can bind to specific mRNA codons. (sequence of 3 nucleotides)

The other end carries the amino acid specified by the codons.

Initiation, Elongation, Termination

The ribosome assembles around the mRNA to be read and the first tRNA (carrying the amino acid MET[AUG]). This initiation complex is needed in order for translation to get started.

The mRNA is read one codon at a time, and the amino acid matching each codon is added to a growing protein chain.

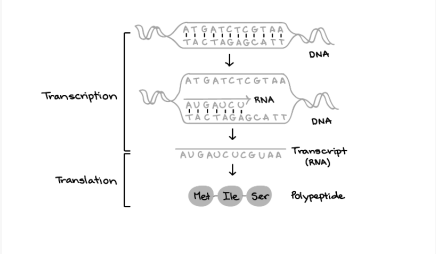
Each time a new codon is exposed,
→a matching tRNA binds to the codon
→the existing amino acid chain (polypeptide) is linked onto the amino acid of the tRNA via a chemical reaction,
→the mRNA is shifted one codon over in the ribosome, exposing a new codon for reading.

tRNAs move through the A, P, and E sites of the ribosome. This process repeats many times as new codons are read and new amino acids are added to the chain.

The finished polypeptide chain is released. It begins when a stop codon (UAG, UAA, or UGA) enters the ribosome, triggering a series of events that separate the chain from its tRNA and allow it to drift out of the ribosome.

The polypeptide may still need to fold into the right 3D shape, undergo processing,get shipped to the right place in the cell, or combine with other polypeptides before it can do its job as a functional protein.

Transcription & Translation



The Central Dogma of Molecular Biology

The Central Dogma (TCD)

- During expression of a protein-coding gene, information flows from DNA → RNA → protein. (This process is known as CD)

The Lac Operon

The Lac Operon of E.Coli

- Conditions: Lactose is available and Glucose is not.
- More information here

3 Types of RNA

mRNA	synthesized using DNA template, attaches to ribosome in cytoplasm and specifies the primary structure of protein
rRNA	molecules...and proteins make up the ribosomes
tRNA	translates between nucleic acid (DNA) and protein lang. by carrying specific amino acids to ribosome, where they recognize the appropriate codons in the mRNA