

DNA Replication

W. Robert Midden
Department of Chemistry
Bowling Green State University

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DNA Replication

How are traits passed on to offspring?

- DNA must be copied into the cells of offspring with extremely high accuracy.
- There are about 9.5 million nucleotides in the DNA of *E. coli*, a common bacterium.
- There are more than 3 billion nucleotides in the DNA of most mammals.
- Errors in even a few of these bases could lead to alteration or loss of critical characteristics of the organism.

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DNA Replication

How is DNA copied?

- Replication of DNA occurs in a process somewhat similar to transcription.
- DNA exists as two strands that are base paired.
- To replicate:
 - DNA strands separate
 - complementary nucleotides base pair to the existing DNA strands
 - DNA polymerase links the nucleotides forming a new complementary strand.

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How accurate is DNA replication?

- DNA polymerase III makes about 1 error in every 100,000 nucleotides.
 - this is the primary enzyme involved in DNA replication in *E. coli*
- But this enzyme also has a “proof reading” activity which corrects these errors with an error rate of about 1 in every 100 nucleotides.
- Overall this gives an error rate of about 1 in 10,000,000 nucleotides.

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How can so many errors be tolerated?

- The error rate of replication is not the whole story.
- Errors in replication can be corrected after replication is complete by DNA repair enzymes.

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How are the errors corrected?

- DNA repair enzymes locate mismatched bases and excise them from the new strand, replacing them with the correct base.
- This lowers the error rate to less than 1 in a billion nucleotides.
- So, on the average there may be about six errors in the replication of each diploid mammalian cell ($\sim 3 \times 10^9$ nucleotides).

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Questions For Discussion

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Genome Size

How many nucleotides are present in the genome of a bacterium such as E. coli and how many are in the genome of a human?

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DNA Replication

Describe the process of DNA replication.

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Semi-Conservative

What does it mean to say that DNA replication is "semi-conservative"?

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The Enzyme That Links Nucleotides

What is the enzyme called that synthesizes new DNA?

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Accuracy of DNA Synthesis

How accurate is the initial synthesis of DNA by DNA polymerase III in E. coli?

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Accuracy of DNA Synthesis

What is the overall accuracy of DNA synthesis by this enzyme in E. coli?

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Lower Overall Error

Why is the overall error frequency so much lower than the error rate of initial synthesis?

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Errors in Human DNA Replication

With this same overall error rate, about how many errors occur in the replication of the human genome?

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Tolerating Errors

How can so many errors be tolerated?

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