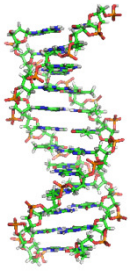
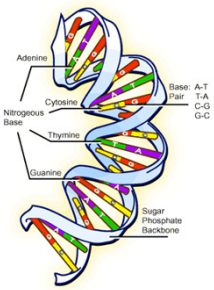
DNA Structure & Replication



Biology 30
Chapter 20



DNA related Learner Outcomes:

- Summarize the historical events that led to the discovery of the structure of DNA
- Describe how genetic information is contained in the sequence of bases in DNA
- Explain how DNA replicates itself (before mitosis)
- Describe how genetic information is "read" or "used" by the body
- Explain how cells can be transformed by inserting new DNA sequences into the genomes
- Explain how a random change (mutation) results in abnormalities or provides a source of genetic variation
- Explain how base sequences give evidence for the relationships among organisms of different species

DNA: The Molecule of Life

- Structure & Function
- Replication
- Protein Synthesis
  - Transcription
  - Translation

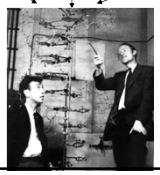
How did we discover what DNA looks like?

X-ray diffraction showed DNA is a helix.

Chemical analysis showed ingredients were sugar, phosphate, and 4 nitrogen bases (AGTC)

A = T
G = C

Chemical analysis showed the number of A and T were the same and the number of G and C were the same in every organism.



EUREKA!!!

DNA: The Molecule of Life

- Watson & Crick credited with the discovery of the structure of DNA in 1953:

Was Franklin Nominated???

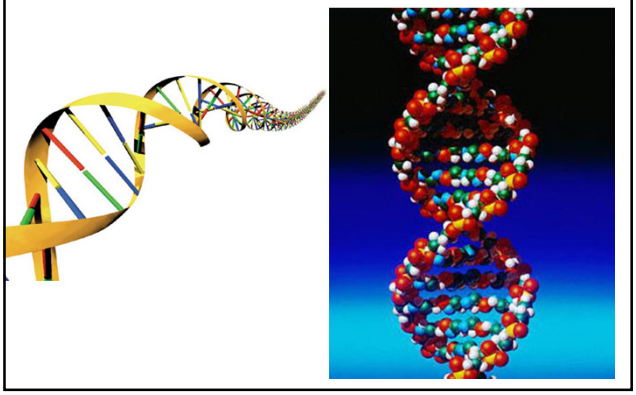
http://nobelprize.org/educational_games/medicine/dna_double_helix/readmore.html

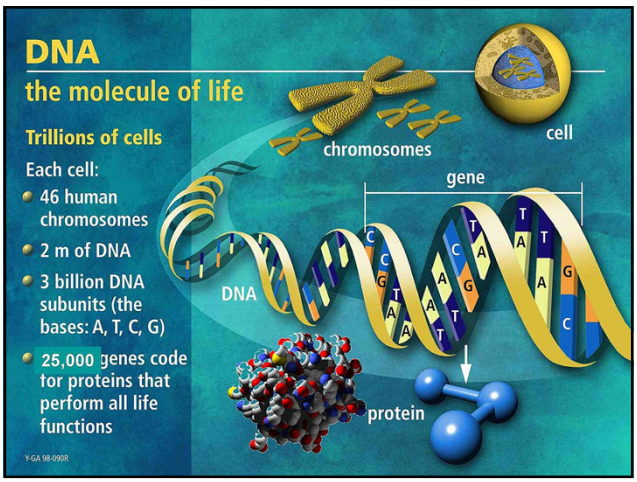
- Many voices have argued that the Nobel Prize should also have been awarded to Rosalind Franklin, since her experimental data provided a very important piece of evidence leading to the solving of the DNA structure. In a recent interview in the magazine Scientific American, Watson himself suggested that it might have been a good idea to give Wilkins and Franklin the Nobel Prize in Chemistry, and him and Crick the Nobel Prize in Physiology or Medicine – in that way all four would have been honored.
- Rosalind Franklin died In 1958. As a rule only living persons can be nominated for the Nobel Prize, so the 1962 Nobel Prize was out of the question. The Nobel archives, at the Nobel Prize-awarding institutions, that among other things contain the nominations connected to the prizes, are held closed. But 50 years after a particular prize had been awarded, the archives concerning the nominees are released. Therefore, in 2008 it was possible to see whether Rosalind Franklin ever was a nominee for the Nobel Prize concerning the DNA helix.
- **The answer is that no one ever nominated her - neither for the Nobel Prize in Physiology or Medicine nor in Chemistry.**

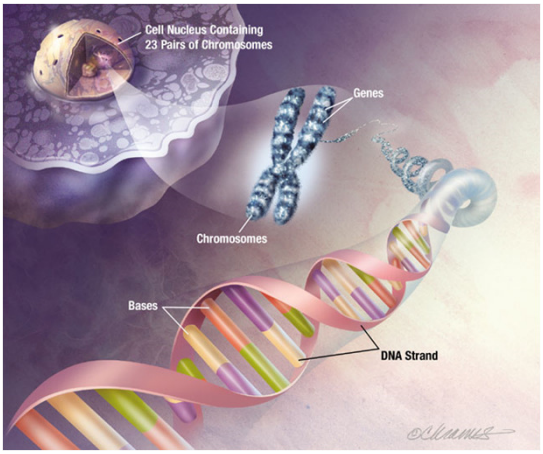
Introductory Media Clips

- DNA Packaging
- DNA Overview

DNA: deoxyribonucleic acid





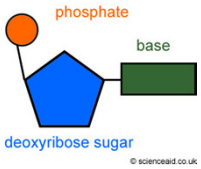


Function of DNA

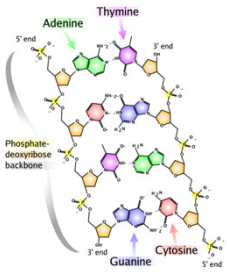
- Stores info used to control development and metabolic activities
- Must be able to replicate with a high degree of accuracy
- Must also be able to undergo rare changes (mutations) for variation

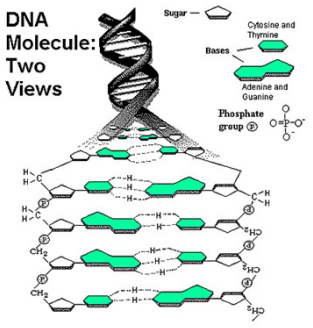
Structure of DNA

- DNA is composed of four nucleotides
- each nucleotide consists of:
  1. a phosphate group
  2. sugar (deoxyribose)
  3. nitrogen bases
     - » adenine (A)
     - » guanine (G)
     - » cytosine (C)
     - » thymine (T)



- Base Pairings
  - – A with T
  - – C with G

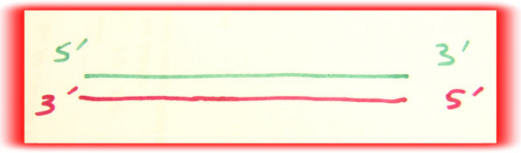


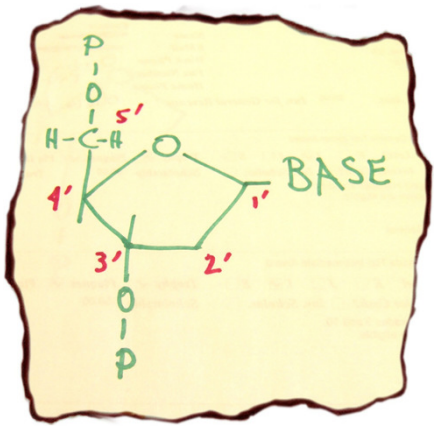


Hydrogen Bonds hold Nitrogen bases together in the center of the molecule

Structure of DNA

- Two strands of twisted nucleotides = double helix
- Sugar phosphate molecules make up the sides of the ladder, bases make up the rungs
- Bases are bonded with hydrogen bonds
- The two strands are **complementary** strands
- Two strands of nucleotides are **antiparallel** (5' to 3' and vice versa)





To Do:

1. Build your complementary DNA strand
2. Circle 1 nucleotide on it
3. Label the 5' and 3' ends of the strand
4. Put your names on and tape it up somewhere in the classroom
5. Start textbook Q's pg. 663 #1-3

Generalizations about Base Pairs

1) # A = # T and # C = # G
2) # purines = # pyrimidines
   (A + G) (C + T)
3) # of A + T rarely = #C + G (species specific)
4) (A + T)/(G + C) ratio is the same for all tissues of a species

Examples:

- Species X has 21% Adenine in their DNA sample. How much Cytosine do they have?

Examples:

- If G = 40%, find % of A

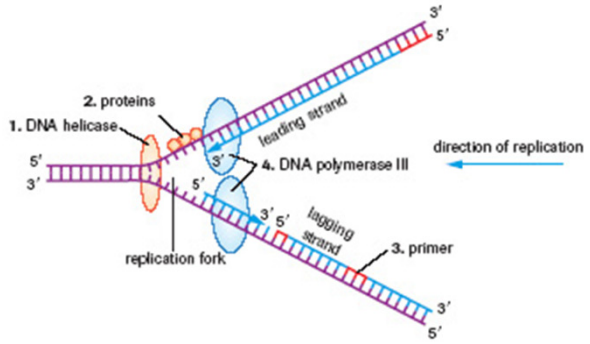
- Try Textbook Questions Pg. 666 # 4 and 7
- Finish Pg. 663 #1-3

Review from yesterday…DNA Structure

- Video clip – DNA Overview

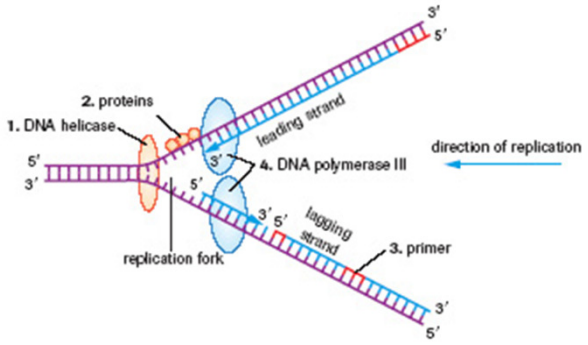
DNA Replication

- Double stranded helix – single strand acts as a ***template***
- STEPS:
  1. DNA has to unwind and unzip (break H-bonds)
     enzymes: *helicase* *gyrase* *(scissors)*
     - The point at which the two template strands are separating is called the replication fork
     - One template strand runs in the 3' to 5' direction and the other in the 5' to 3' direction.



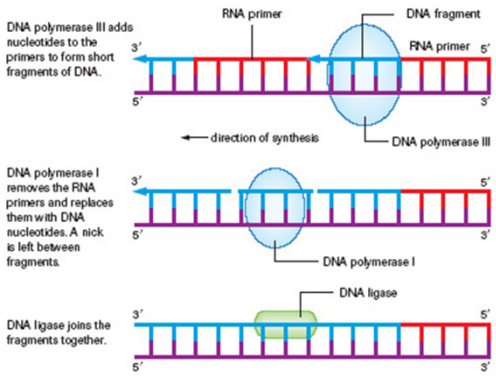
DNA Replication

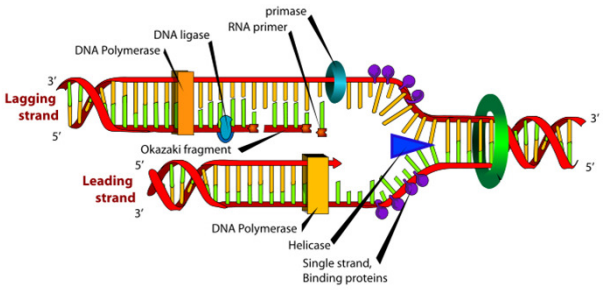
2. Complimentary nucleotides pair up along the original DNA strand (***DNA polymerase III***)
   - A short piece of RNA, called a ***primer***, is attached to the template strand
   - Nucleotides are added from the primer in the 5' to 3' direction ONLY!
   - **Leading Strand** – new strand of DNA synthesized continuously towards replication fork
   - **Lagging Strand** – new strand of DNA synthesized away from replication fork in short fragments later joined together.



DNA Replication

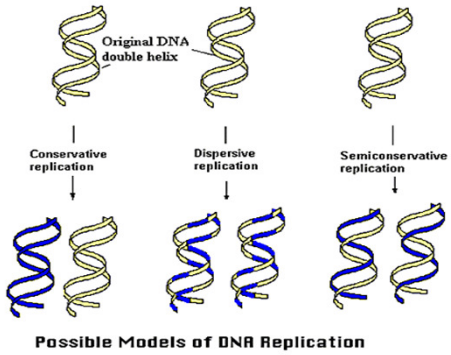
3. Primers are cut out of the lagging strand and are replaced with DNA nucleotides by an enzyme called ***DNA polymerase I***
4. Another enzyme, ***DNA ligase***, joins the DNA fragments together
5. ***DNA polymerase*** (I and III) proof-read to ensure no mistakes have been made
   - When a mistake occurs, the DNA polymerases cut out the nucleotide then continue adding nucleotides to the complimentary strand.





DNA Replication Animation

This method of replication is called "Semi-conservative Replication"



Possible Models of DNA Replication

Replicate this strand of DNA

T	A
C	G
A	T
G	C

"You're the mother and those are your children? — I'd like to see a DNA test."

To Do:

- Textbook Q's p. 663 #1-3
- Page 666 #1-7 (omit 6)
  - (already assigned 4 and 7)
- Worksheet: DNA Replication – An Overview