General Biology 1
BIO1101
Syllabus & Textbook: http://goo.gl/rvgdrH

Lecturer: Michael Gotesman, PhD
Email: mgotesman@citytech.cuny.edu

Letter Grade	Numerical Ranges
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

OER
Lecture:https://openlab.citytech.cuny.edu/bio-oer/page/2/
Lab: https://openlab.citytech.cuny.edu/bio-oer/

Grade Breakdown:
Exams (4): 20% Each
Quizzes: 20% Average

Consider this cross: Rr x Rr

- Think about the gametes that each could produce and assign a fraction to each
- Fertilization occurs. What percentage would be…
- RR ? Rr ? rr ?
- What fraction would be the dominant phenotype?

Consider this cross: Tt x tt

- What fraction would be tt?
- What fraction would be the recessive phenotype?

Consider this cross: X^bY X X^BX^b

- What type of children would they have (B = Blue, b = green eye)

Consider this cross: GgEe x GgEE

- What fraction would be ggEE?
- What fraction would be GgEe?
- What fraction would be ggee?

1)Cell Theory:

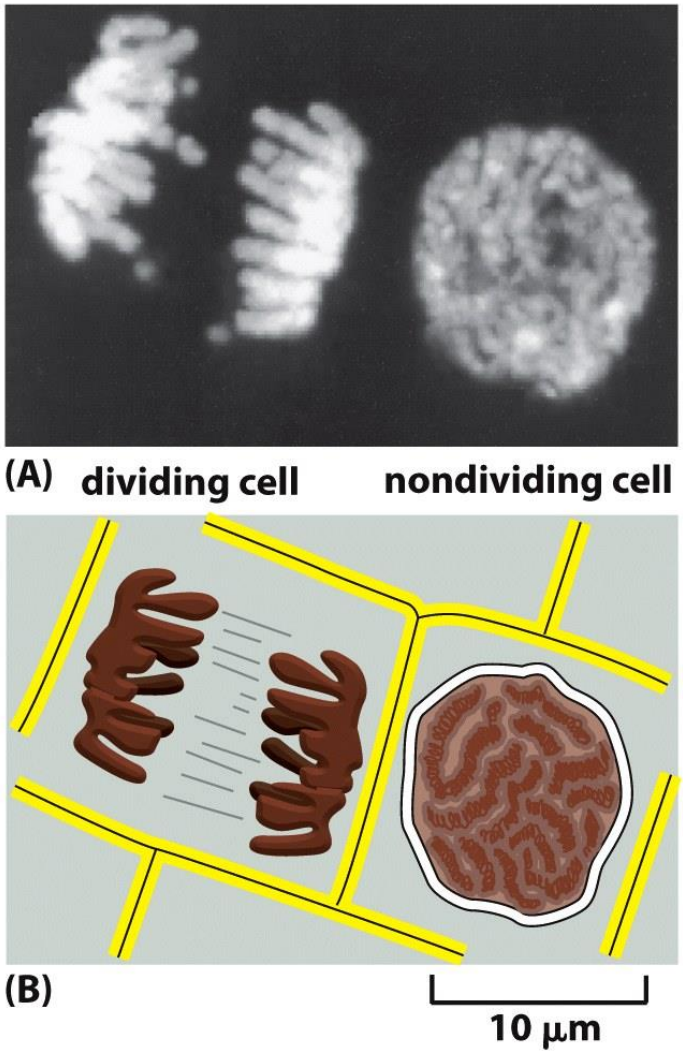
1. All living things or organisms are made of cells and their products.

2. New cells are created by old cells dividing into two.

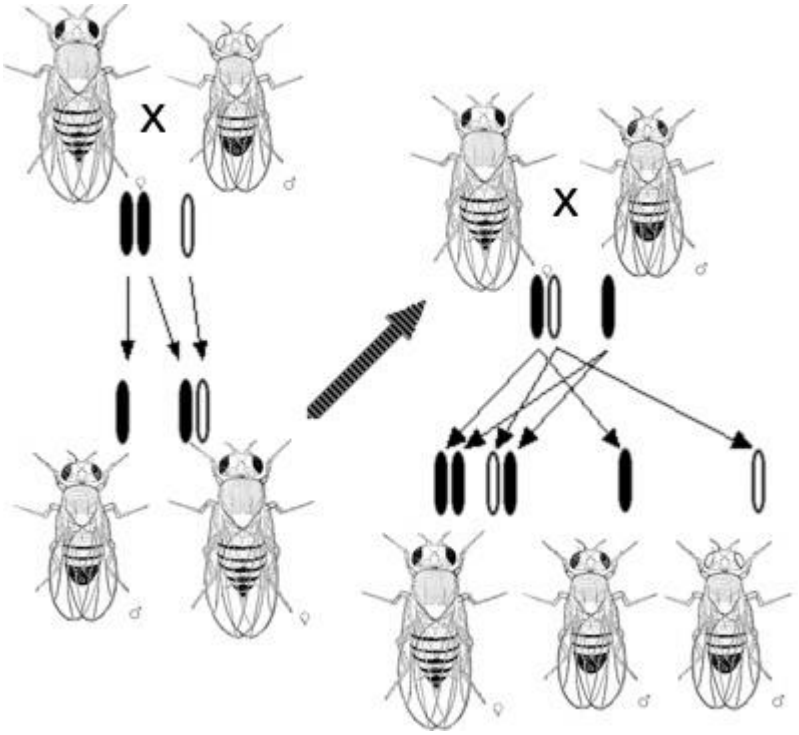
3. Cells are the basic building units of life.

How is the information for life inherited?

Chromosome Condensation

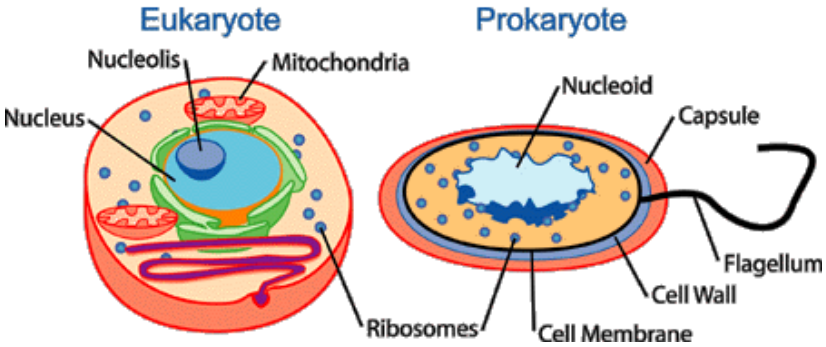


1911 – Thomas Hunt Morgan



What are chromosomes made of?

Genetic Information: Chromosomes



- DNA is assembled into packets → Chromosomes
  - **Chromosomes** are organized structures of DNA and protein that contain many genes, regulatory elements and other nucleotide sequences
- Chromosomes are located in the Nucleus of Eukaryotes
- Prokaryotes have Chromosomes in the Nucleoid region
- Prokaryotes have accessory **Plasmids** of circular DNA
- Mitochondria and Chloroplasts have genomes like prokaryotes

1929 – Frederick Griffith Experiment

What is the material of genetic inheritance?

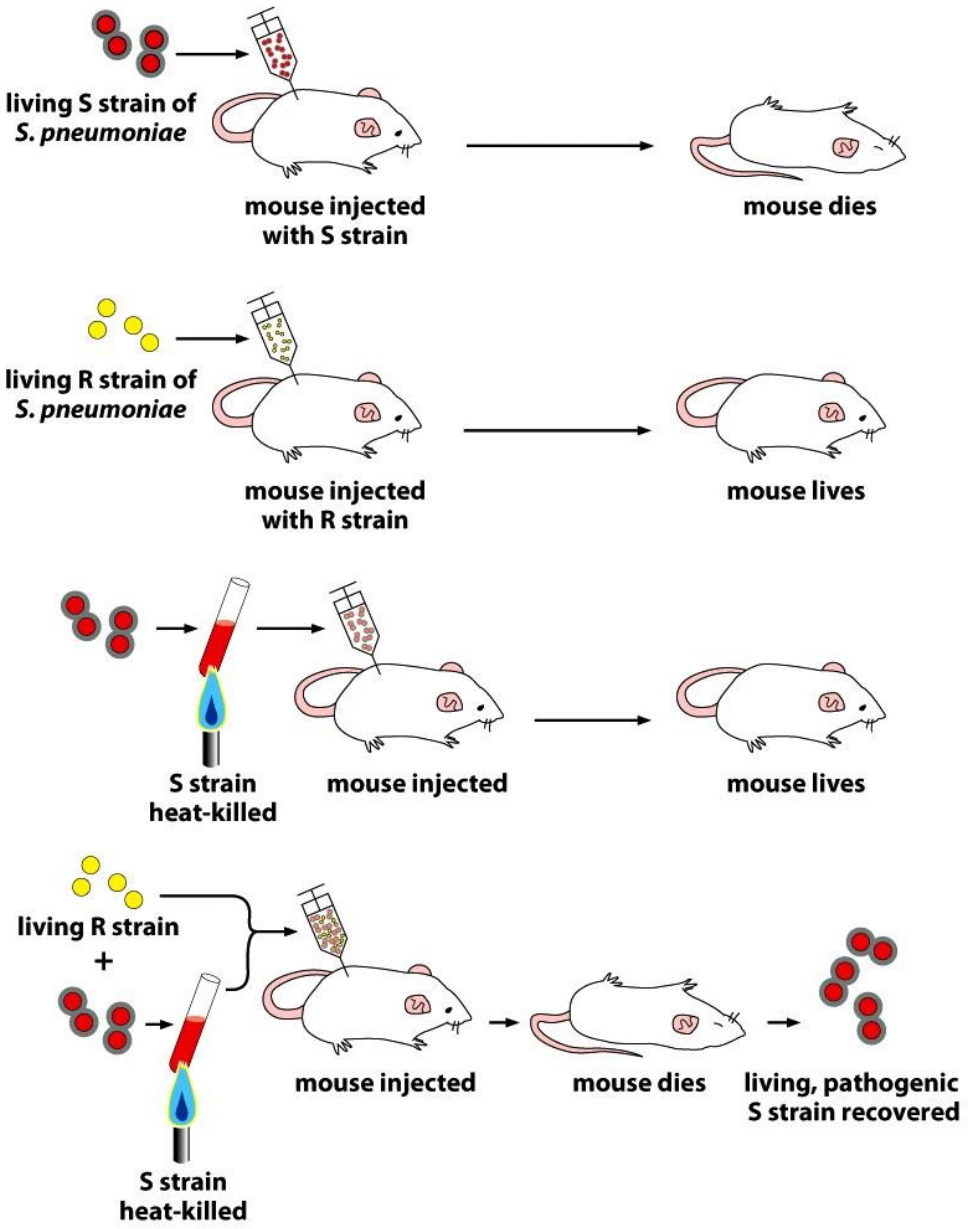
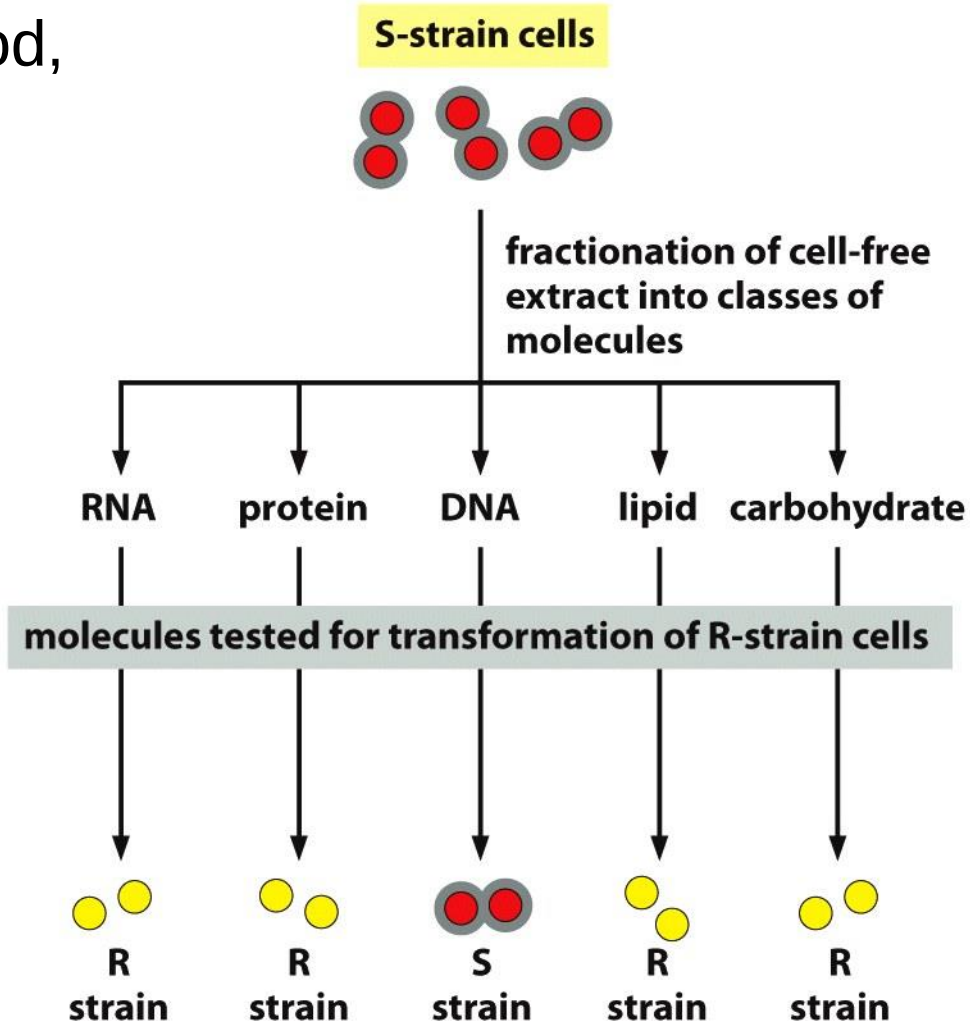


Figure 5-3 *Essential Cell Biology* (© Garland Science 2010)

What is the “transforming” agent?

- *What are the major macromolecules?*
- *Which is the most likely candidate based on setting up rules of inheritance?*
- *Which is the most diverse type of biologically significant macromolecule?*
- *How would you go about deciphering which is the transforming agent?*

Avery, MacLeod, McCarty Experiment

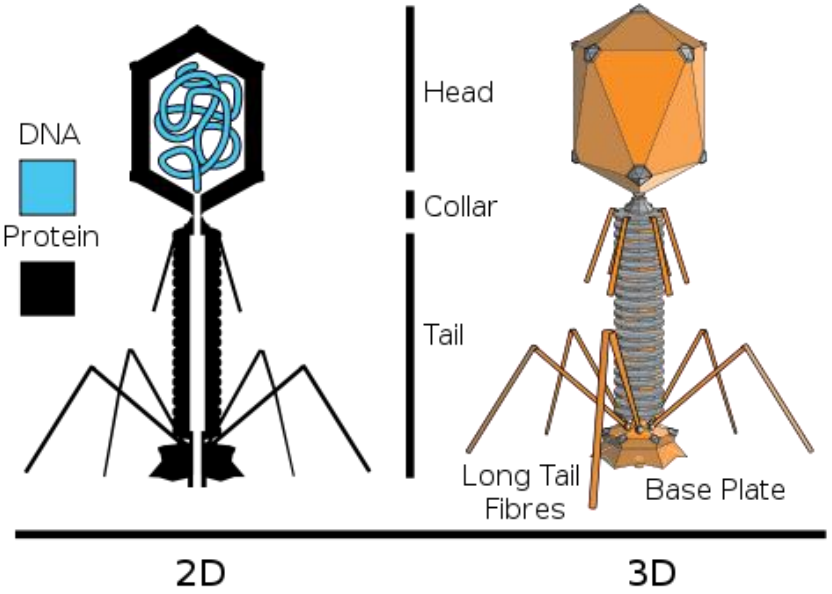


1944

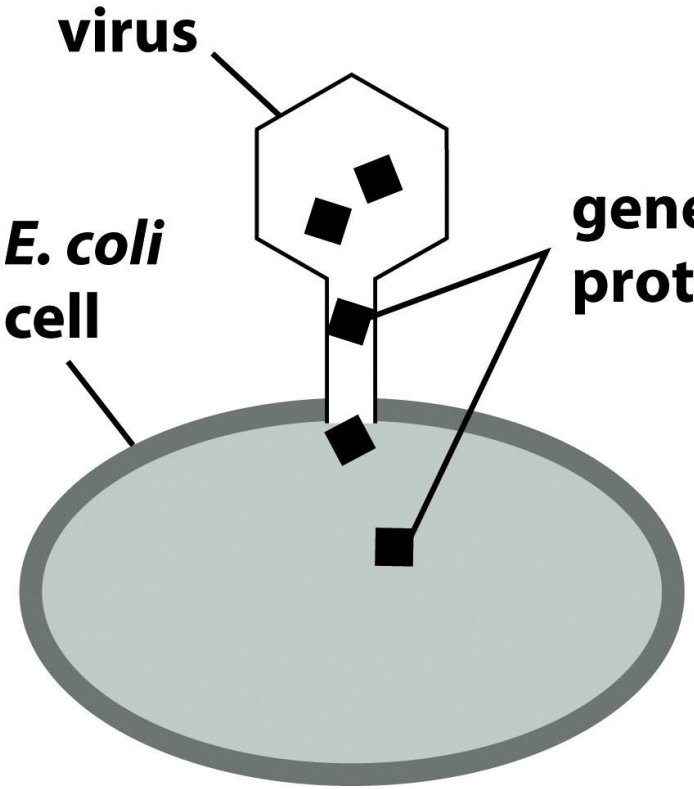
CONCLUSION: The molecule that carries the heritable information is DNA.

DNA

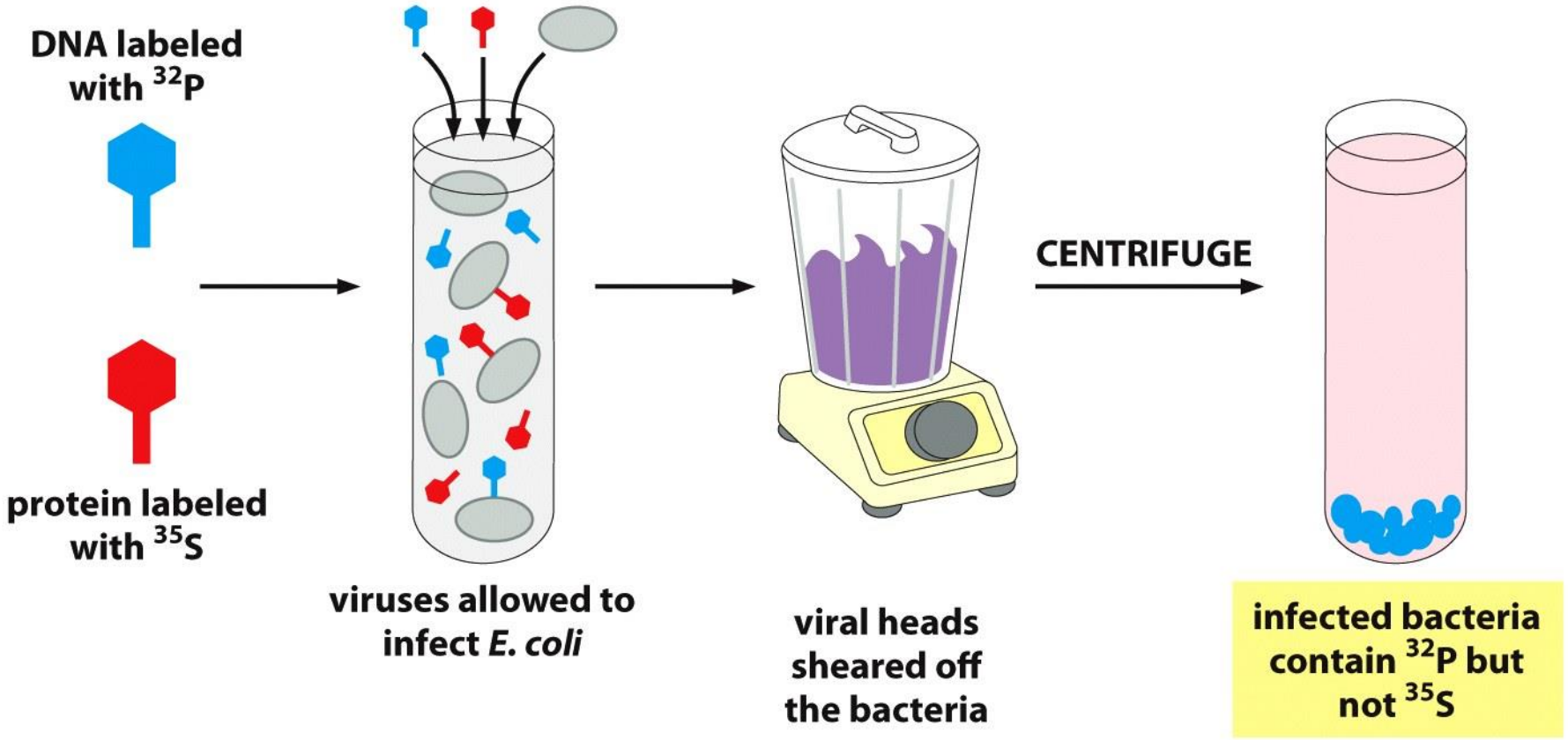
Figure 5-4 *Essential Cell Biology* (© Garland Science 2010)



Hershey, Chase Experiment



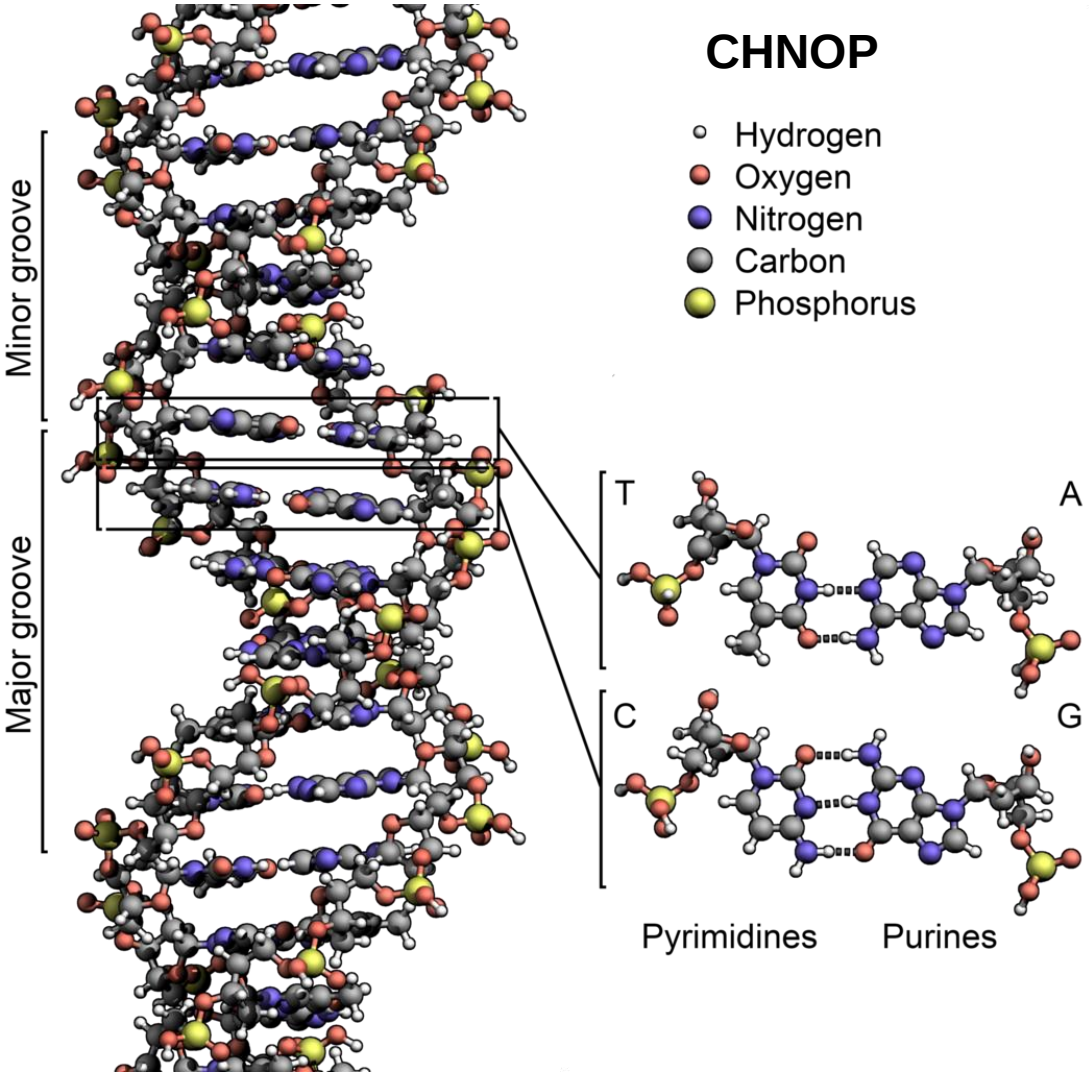
What elements can we use to discriminate between amino acids and nucleotides?

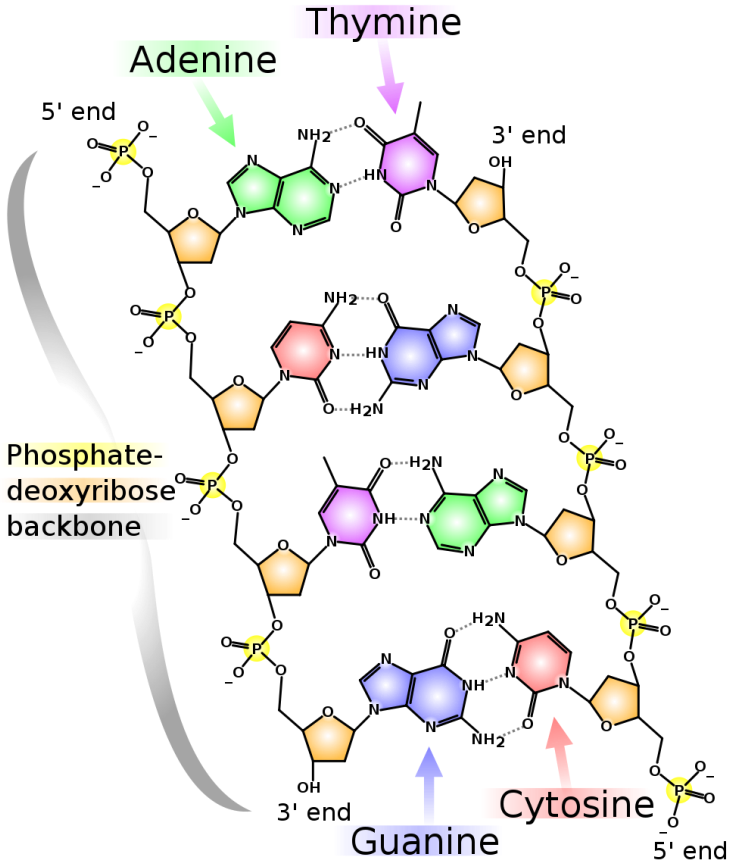


1952

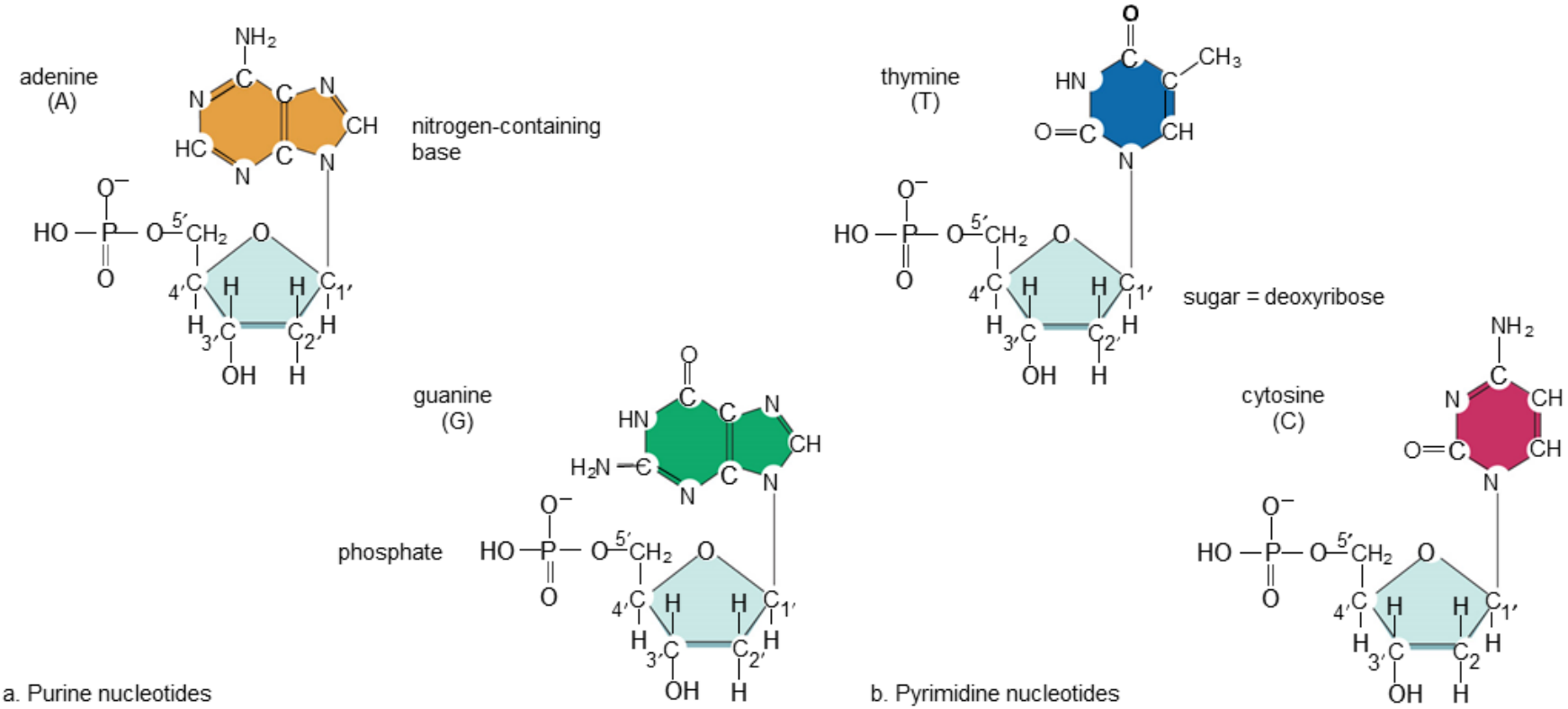
Figure 5-5b *Essential Cell Biology* (© Garland Science 2010)

Genetic Information: DNA





Nucleotide Composition of DNA



DNA Composition in Various Species (%)				
Species	A	T	G	C
Homo sapiens (human)	31.0	31.5	19.1	18.4
Drosophila melanogaster (fruit fly)	27.3	27.6	22.5	22.5
Zea mays (corn)	25.6	25.3	24.5	24.6
Neurospora crassa (fungus)	23.0	23.3	27.1	26.6
Escherichia coli (bacterium)	24.6	24.3	25.5	25.6
Bacillus subtilis (bacterium)	28.4	29.0	21.0	21.6

c. Chargaff's data

Chargaff's Rules

- The amounts of A, T, G, and C in DNA:
  - Identical in identical twins
  - Varies between individuals of a species
  - Varies more from species to species
- In each species, there are equal amounts of:
  - A & T
  - G & C

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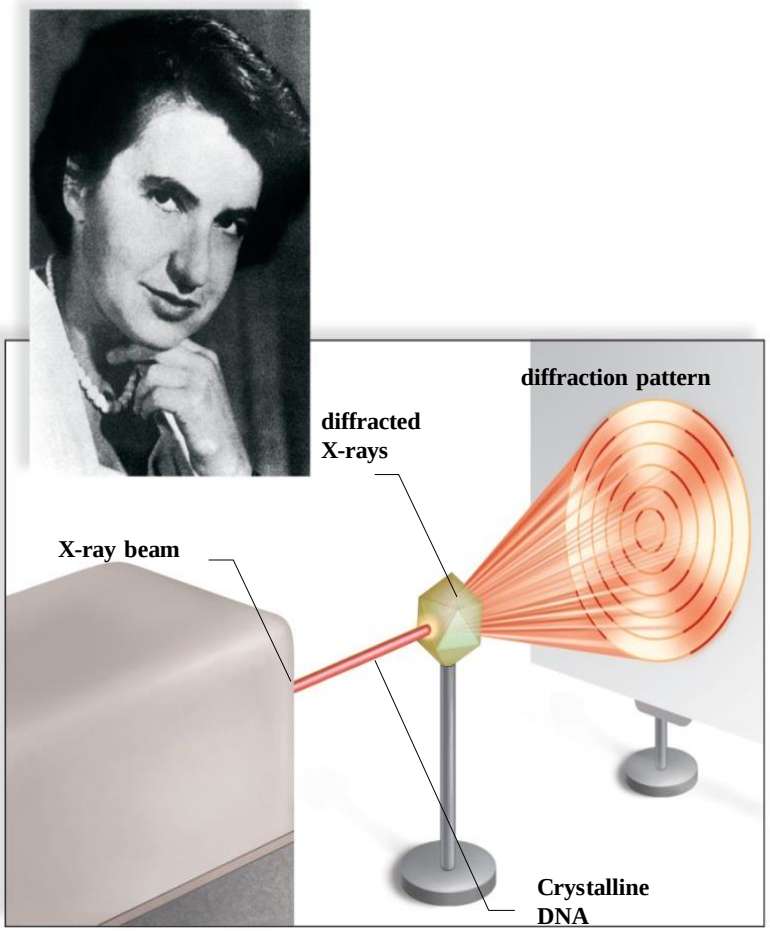
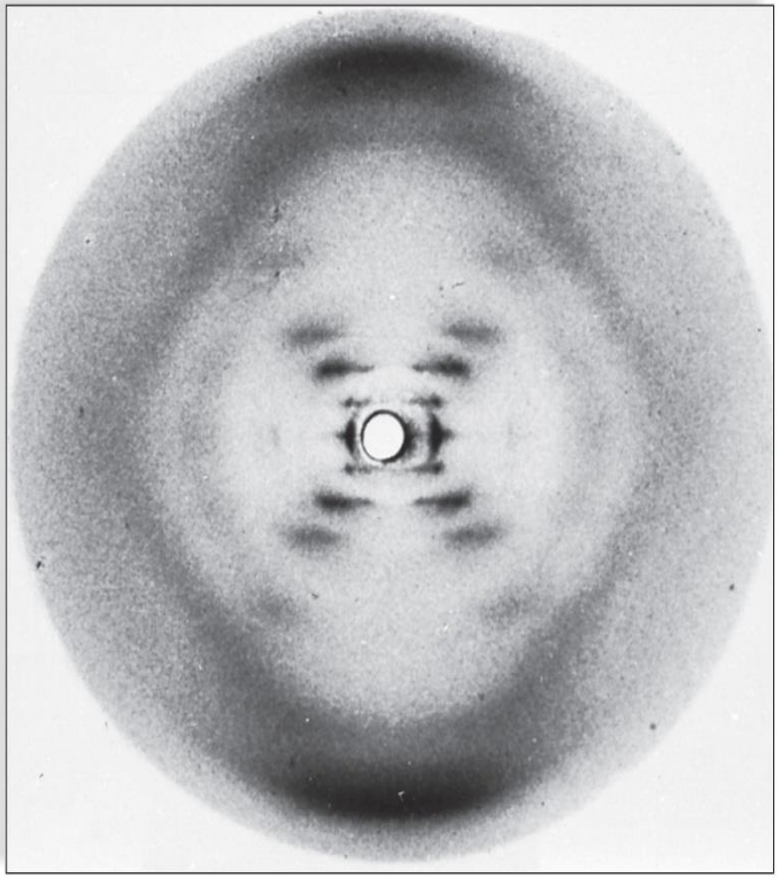
c. Chargaff's data

- All this suggests DNA uses complementary base pairing to store genetic information in the cell
- Human chromosome estimated to contain, on average, 140 million base pairs

Rosalind Franklin: Structure of DNA

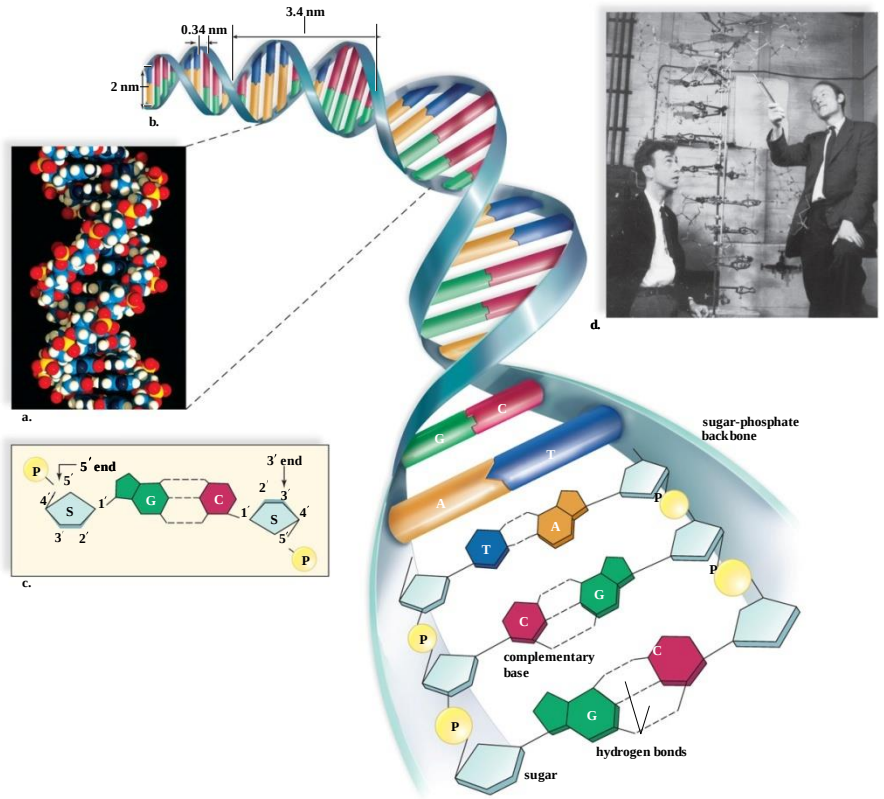




- DNA is a repetitive polymer of nucleotides
- Franklin crystallized DNA observed the scatter of X-rays
- The pattern revealed a spacing of 0.34nm between base pairs

Watson-Crick Double helix

- Maurice Wilkins provided the diffraction pattern to Watson and Crick
- They recalled that the pattern illustrated was representative of a helical structure
- Deduction of complimentarity from Chargaff's rules resulted in the idea of a **double helix** with the phosphate-sugar backbone on the outside
- Franklin's diffraction also indicated the helix turned once every 10 bases → 0.34nm between steps and 3.4 nm between full turns



1953 – Nature
1962 – Nobel prize

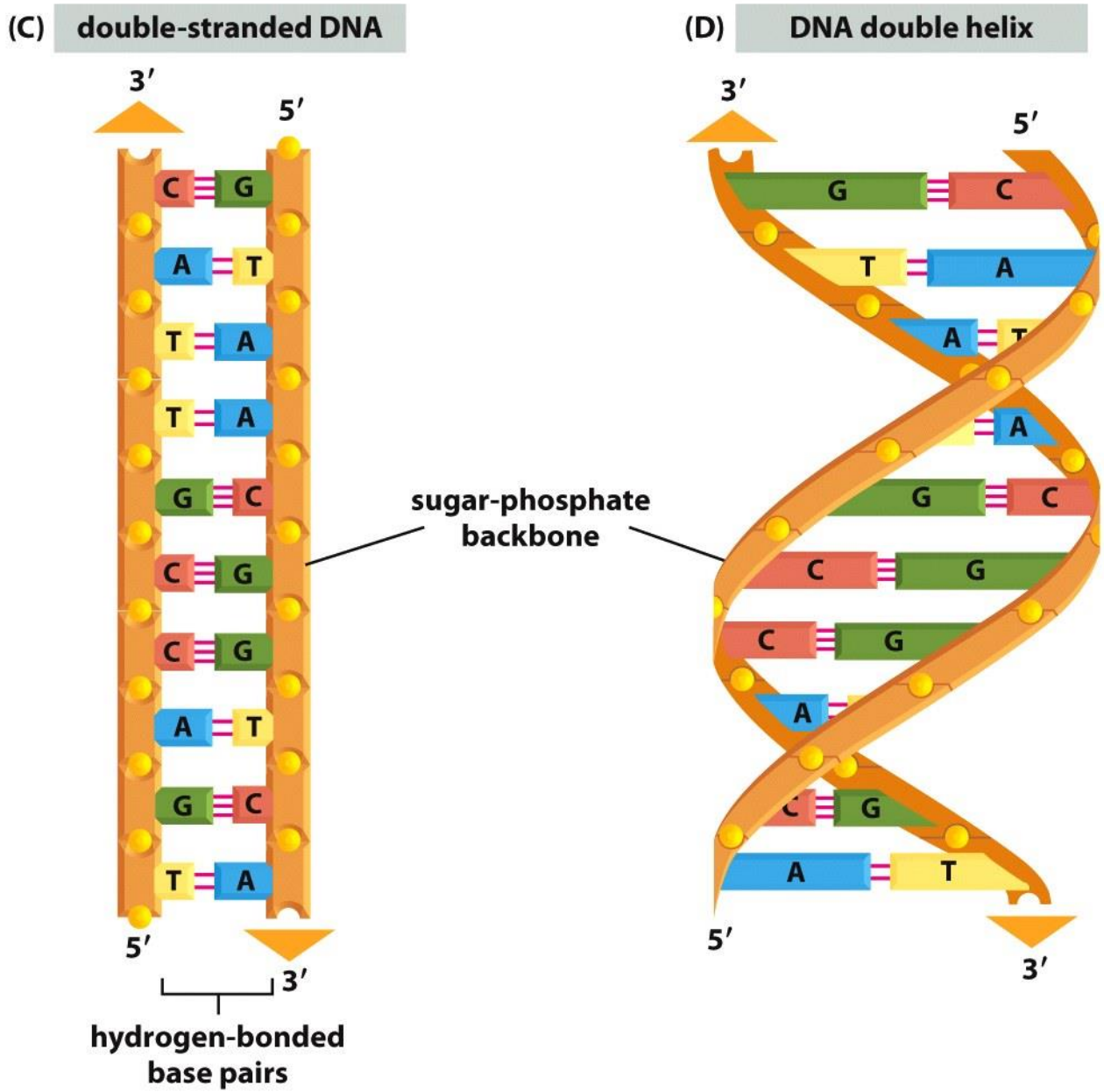
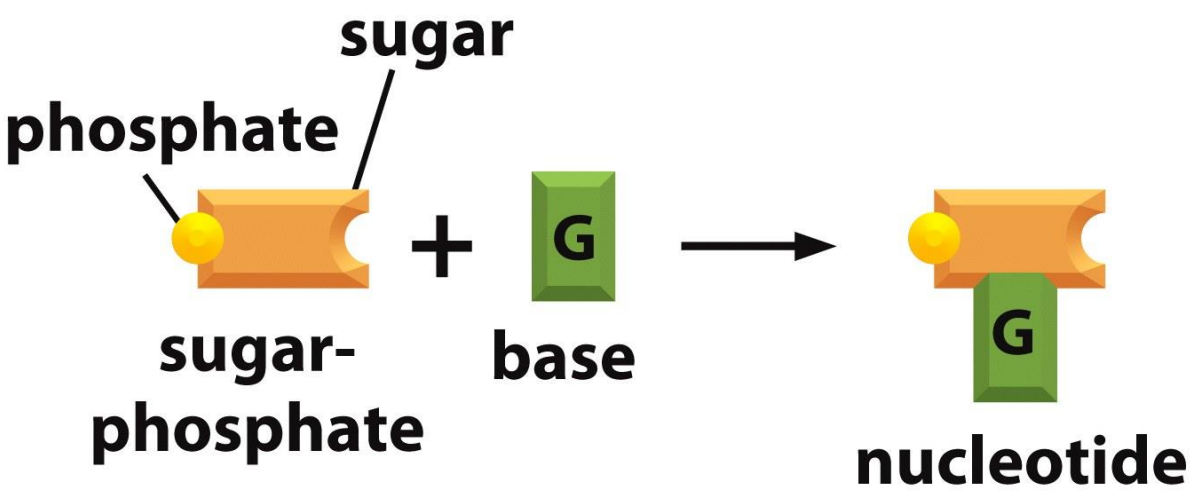
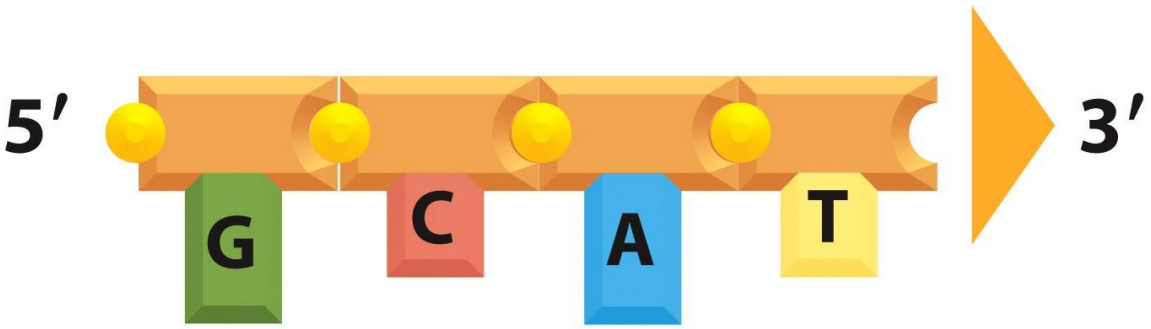


Figure 5-2c *Essential Cell Biology* (© Garland Science 2010)

building blocks of DNA



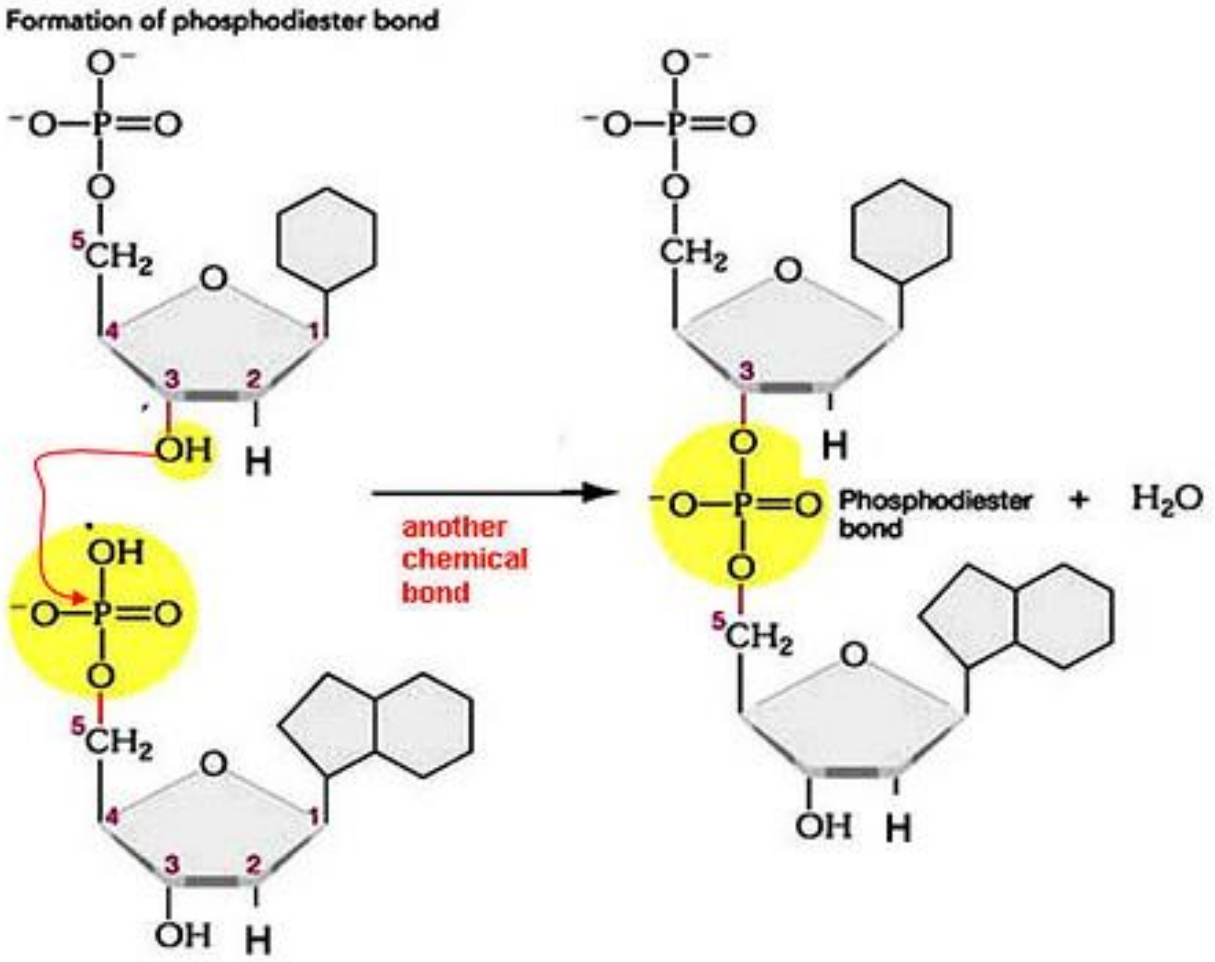
DNA strand



- *What's the mechanism of replication called?*
- *What's the structure of DNA?*

DNA Elongation

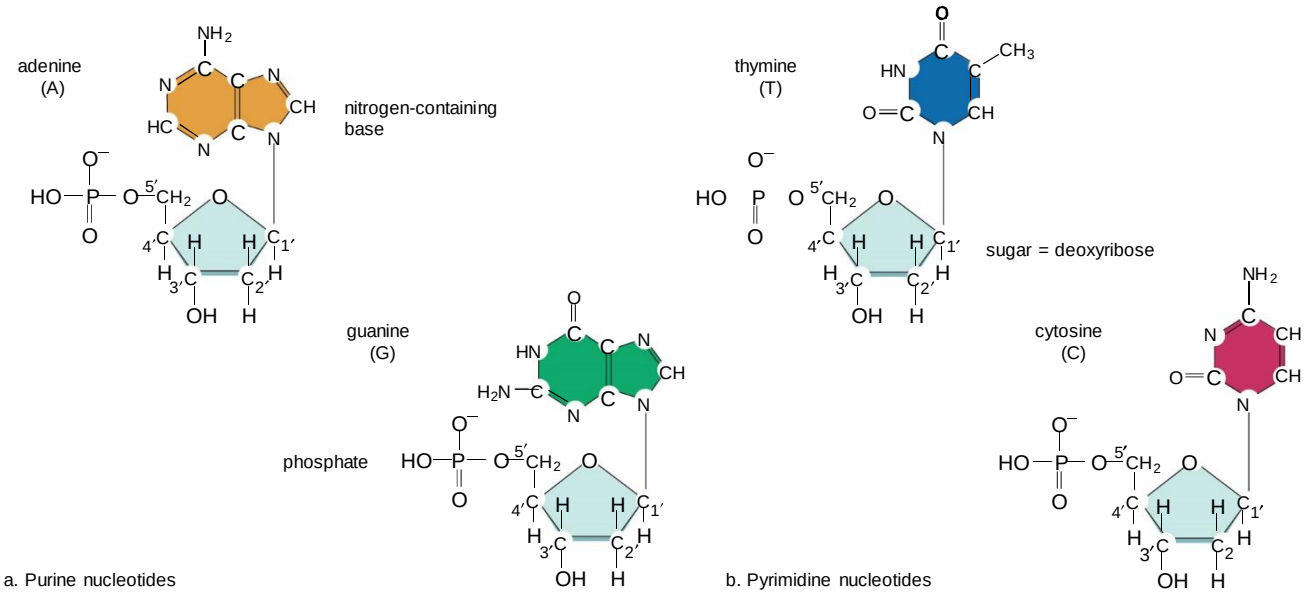
1. **Phosphodiester linkage**
2. **<u>Always</u> 5' → 3' direction**



Structure of DNA

- DNA contains:
  - Two Nucleotides with purine bases
    - Adenine (A)
    - Guanine (G)
  - Two Nucleotides with pyrimidine bases
    - Thymine (T)
    - Cytosine (C)

Nucleotide Composition of DNA



a. Purine nucleotides

b. Pyrimidine nucleotides

DNA Composition in Various Species (%)				
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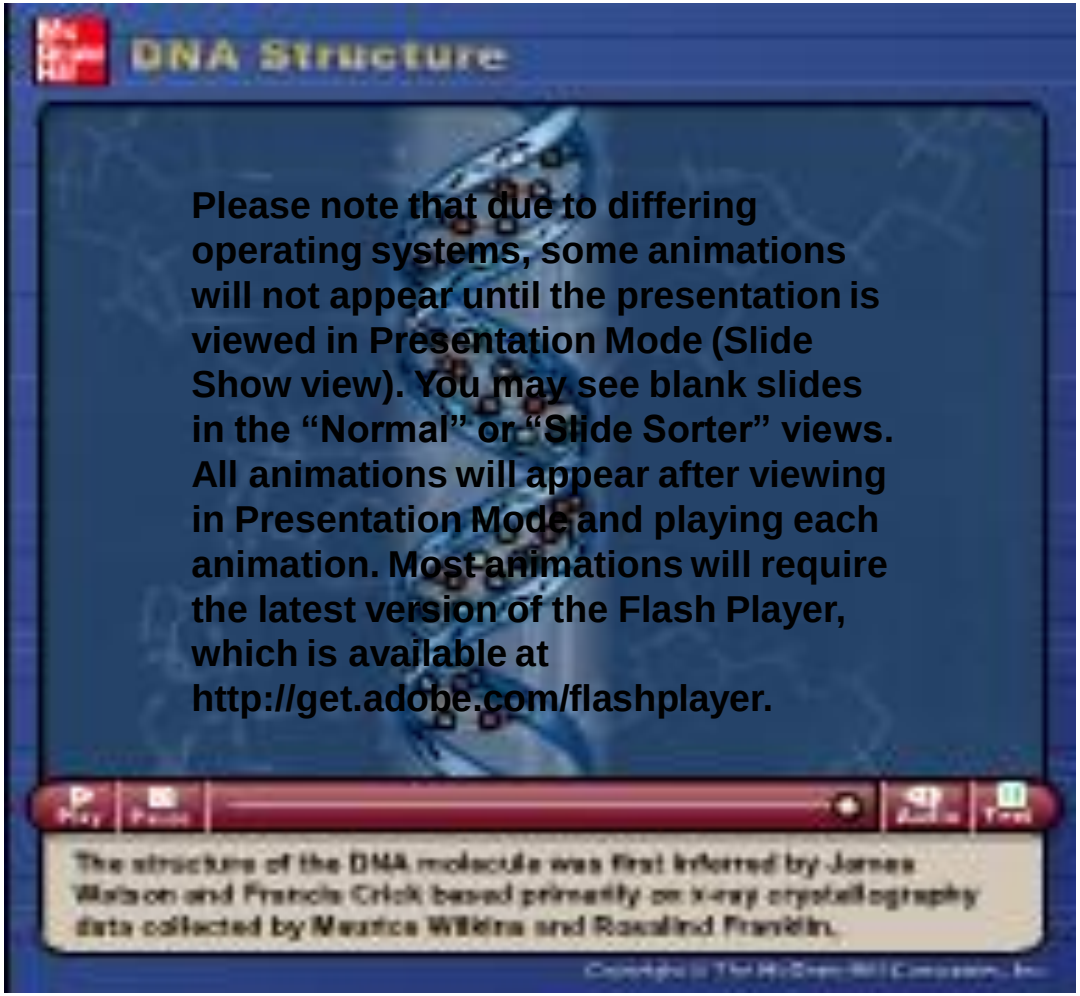
c. Chargaff's data

Animation


DNA Structure
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Play
Pause
Audio
Text
The structure of the DNA molecule was first inferred by James Watson and Francis Crick based primarily on x-ray crystallography data collected by Maurice Wilkins and Rosalind Franklin.

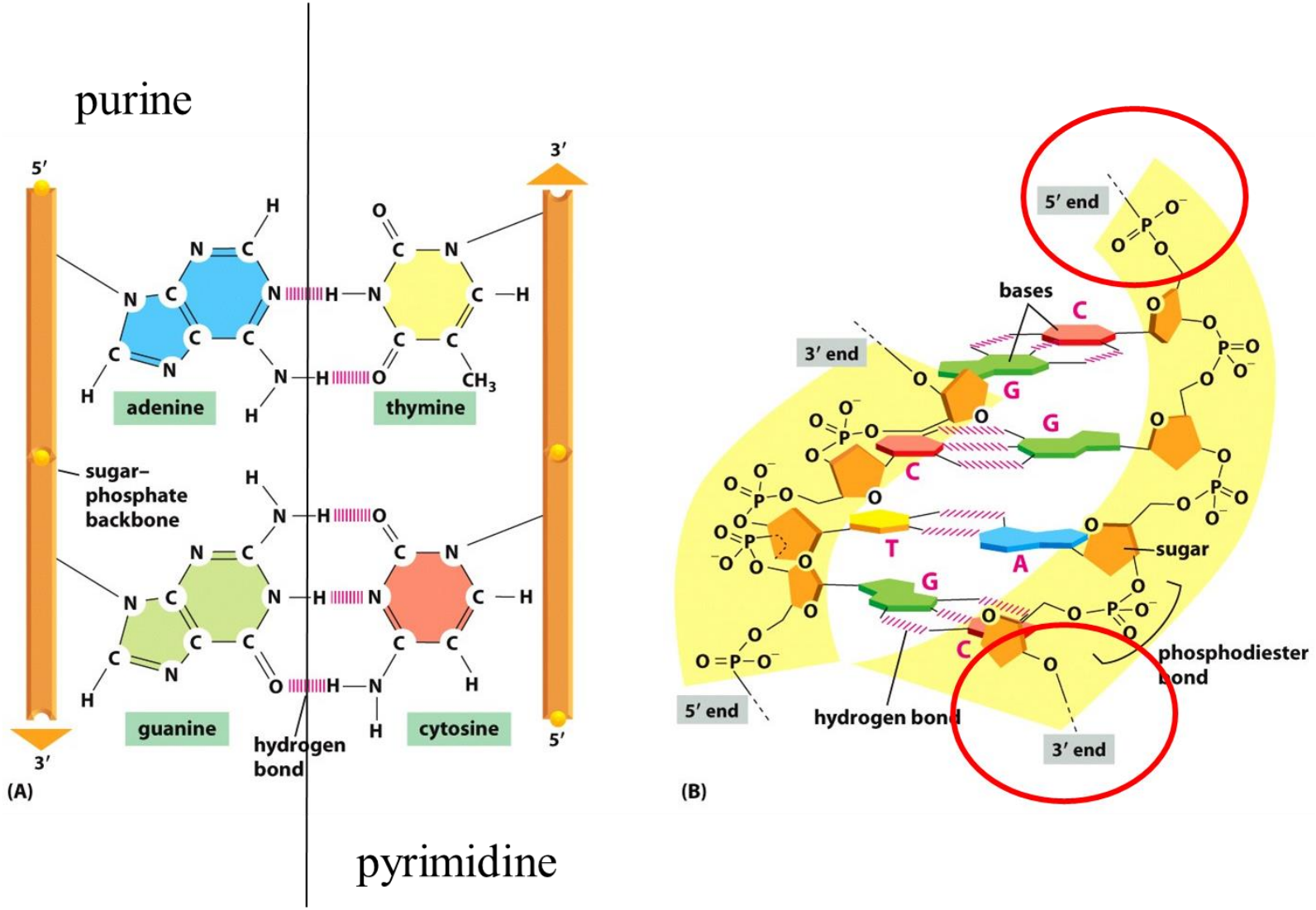
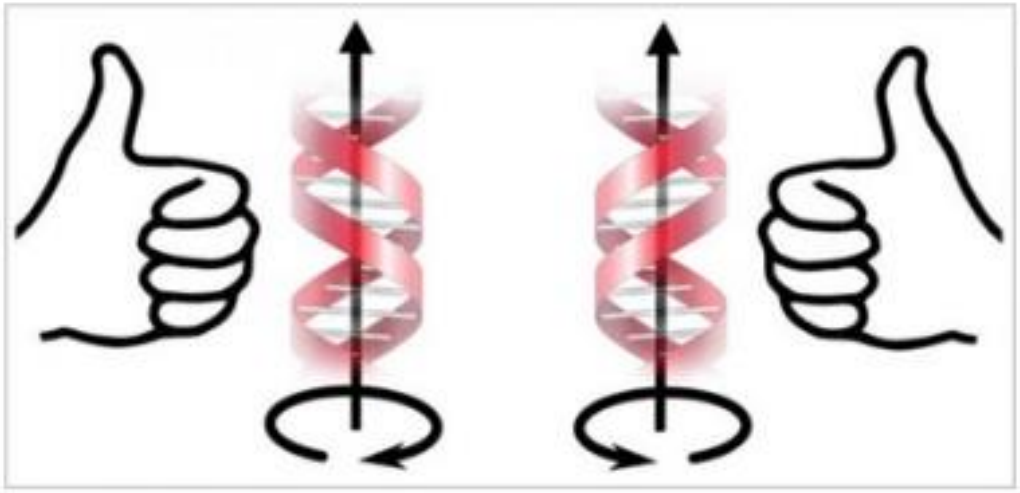


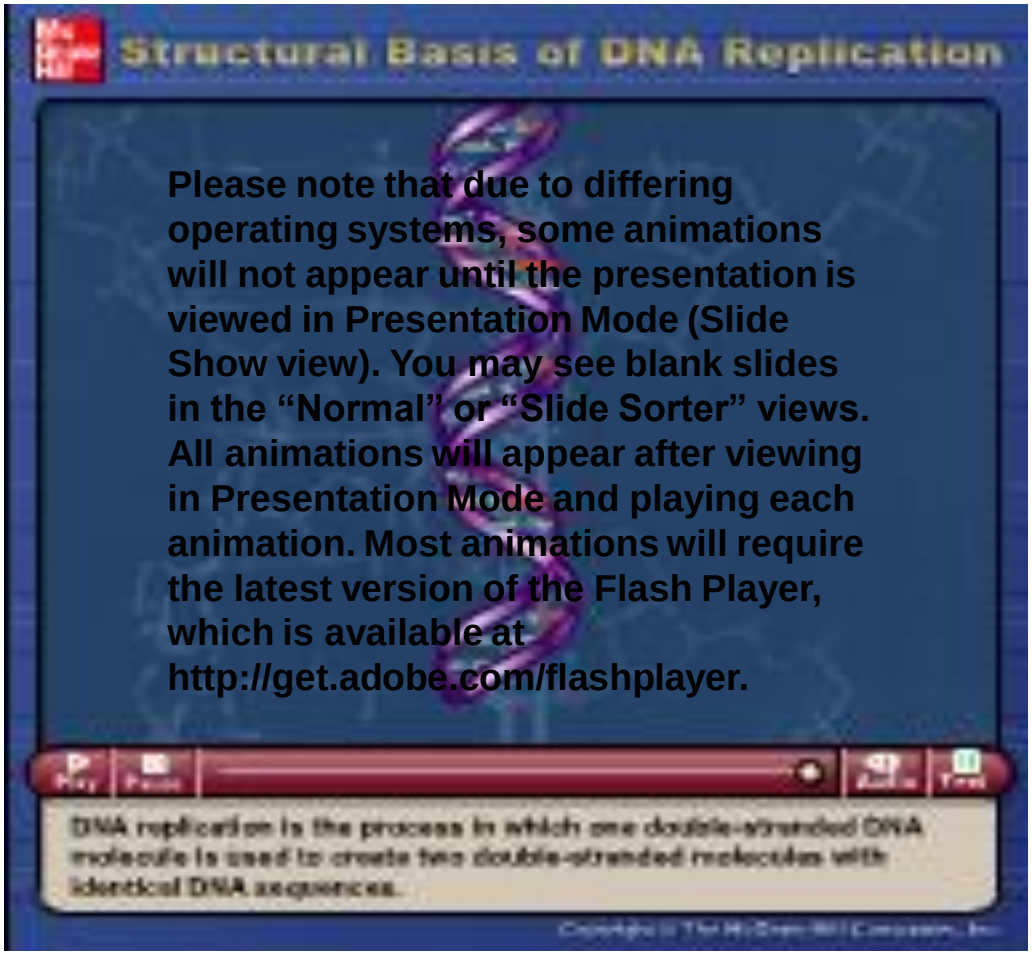
Figure 5-6 *Essential Cell Biology* (© Garland Science 2010)

DNA structure

3) The two chains wind around right handedly - right handed double helix.



Animation


Structural Basis of DNA Replication
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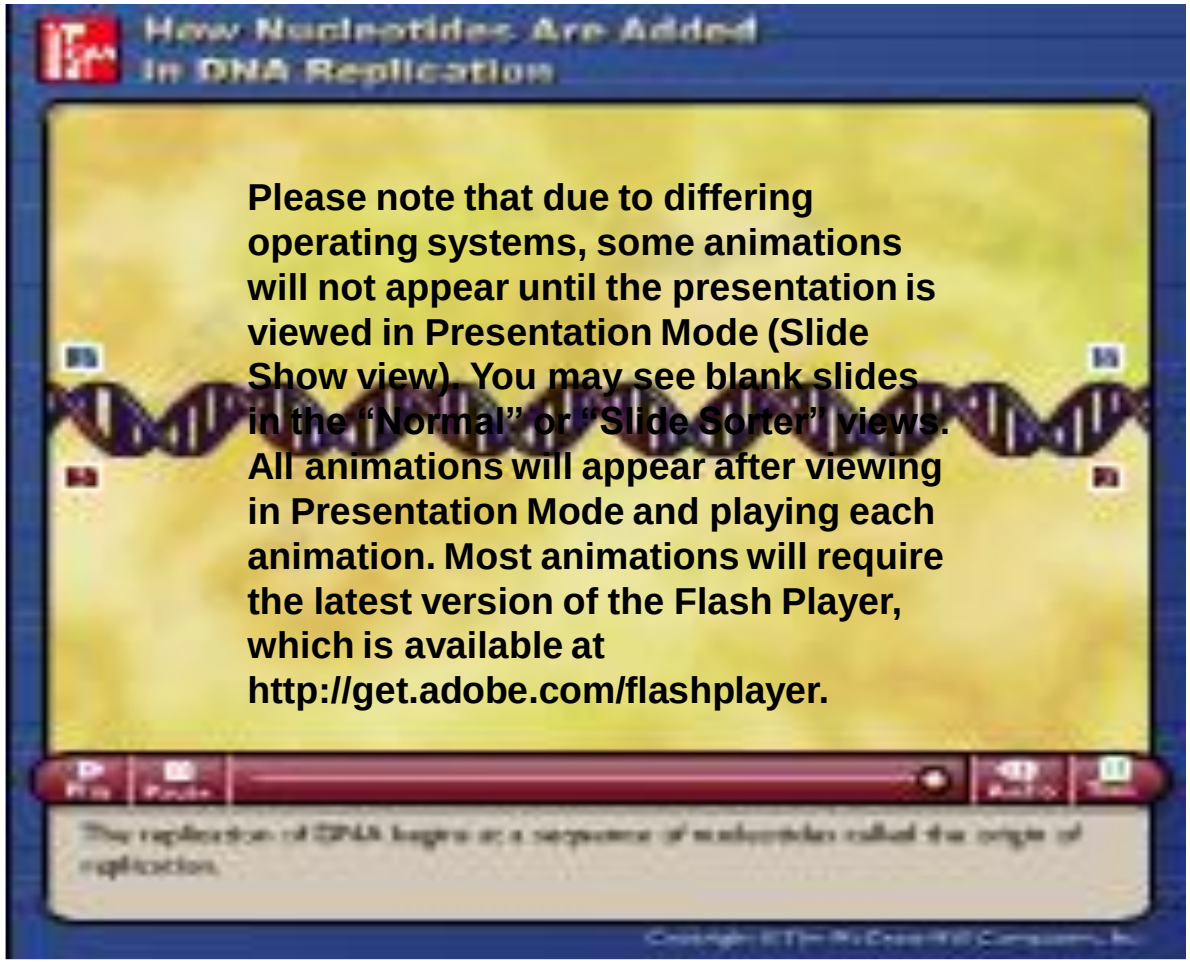
Play
Pause
Audio
Text
DNA replication is the process in which one double-stranded DNA molecule is used to create two double-stranded molecules with identical DNA sequences.

Animation


How Nucleotides Are Added
in DNA Replication
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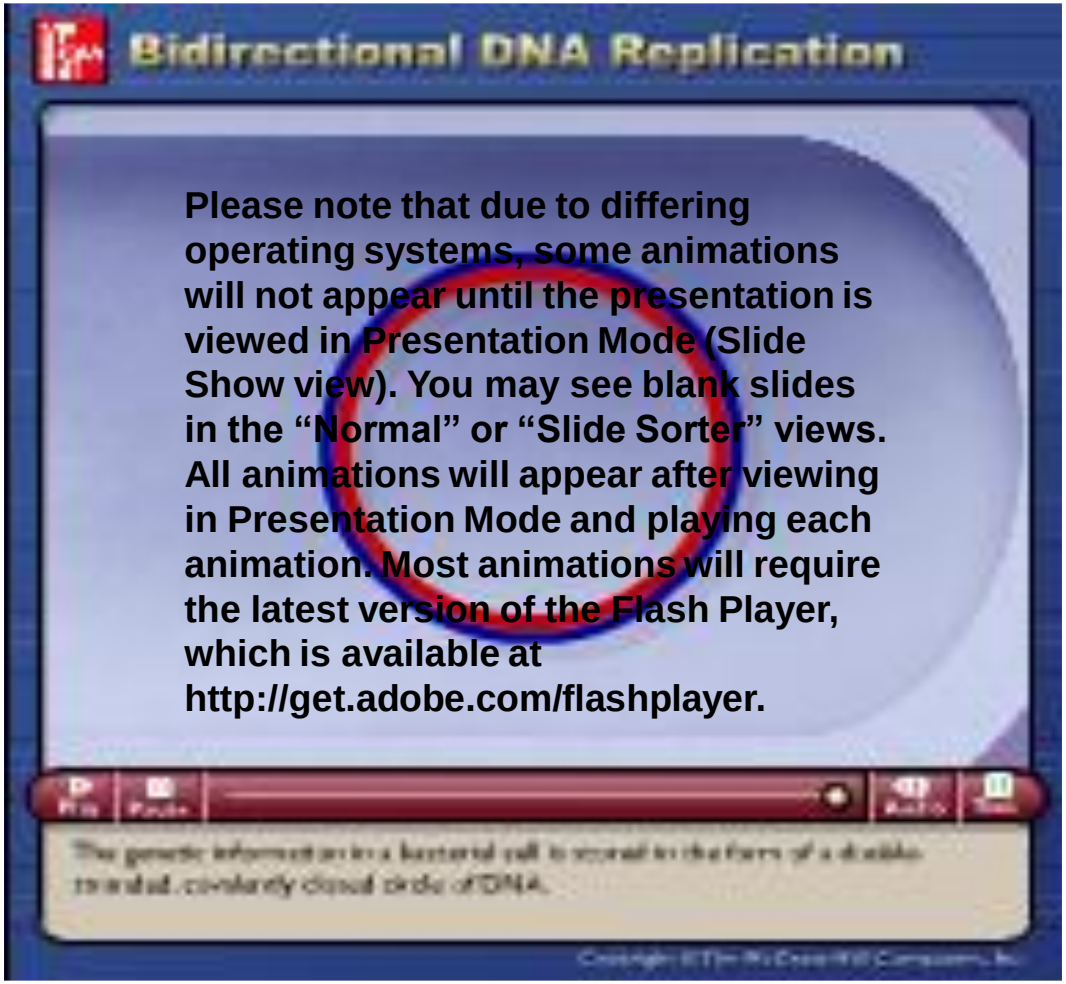
Replication of DNA

- DNA replication is the process of copying a DNA molecule.
- Replication is **semiconservative**, with each strand of the original double helix (*parental* molecule) serving as a **template** (mold or model) for a new strand in a *daughter* molecule.

Animation


Bidirectional DNA Replication
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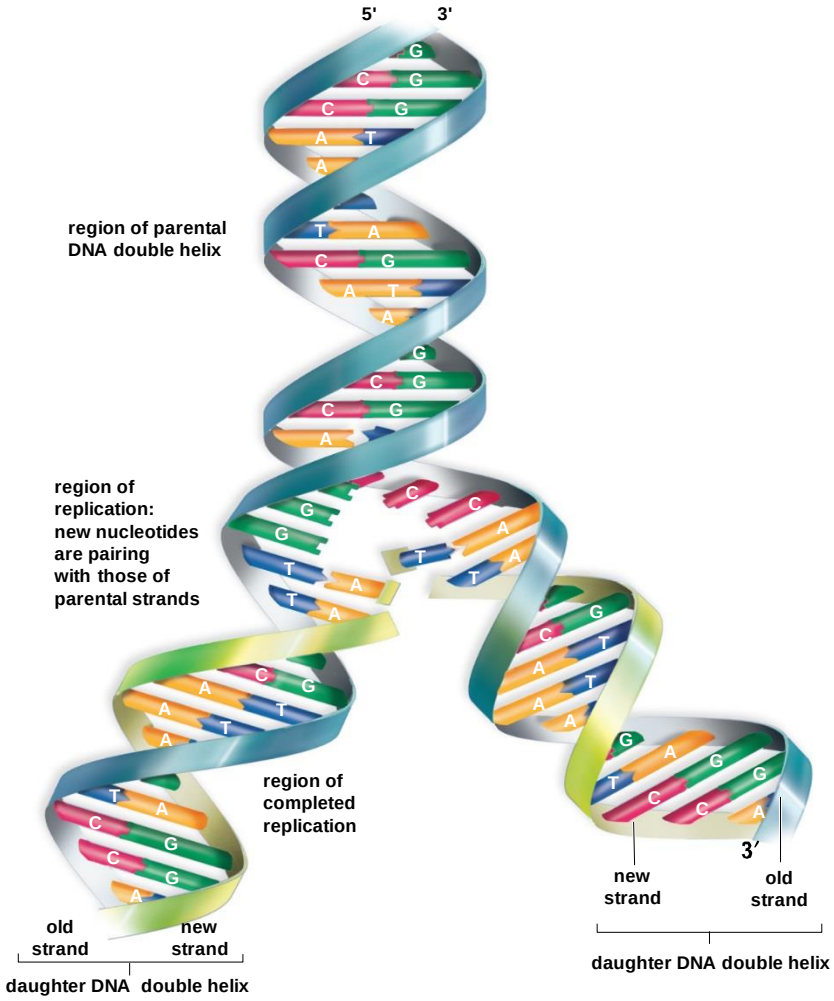
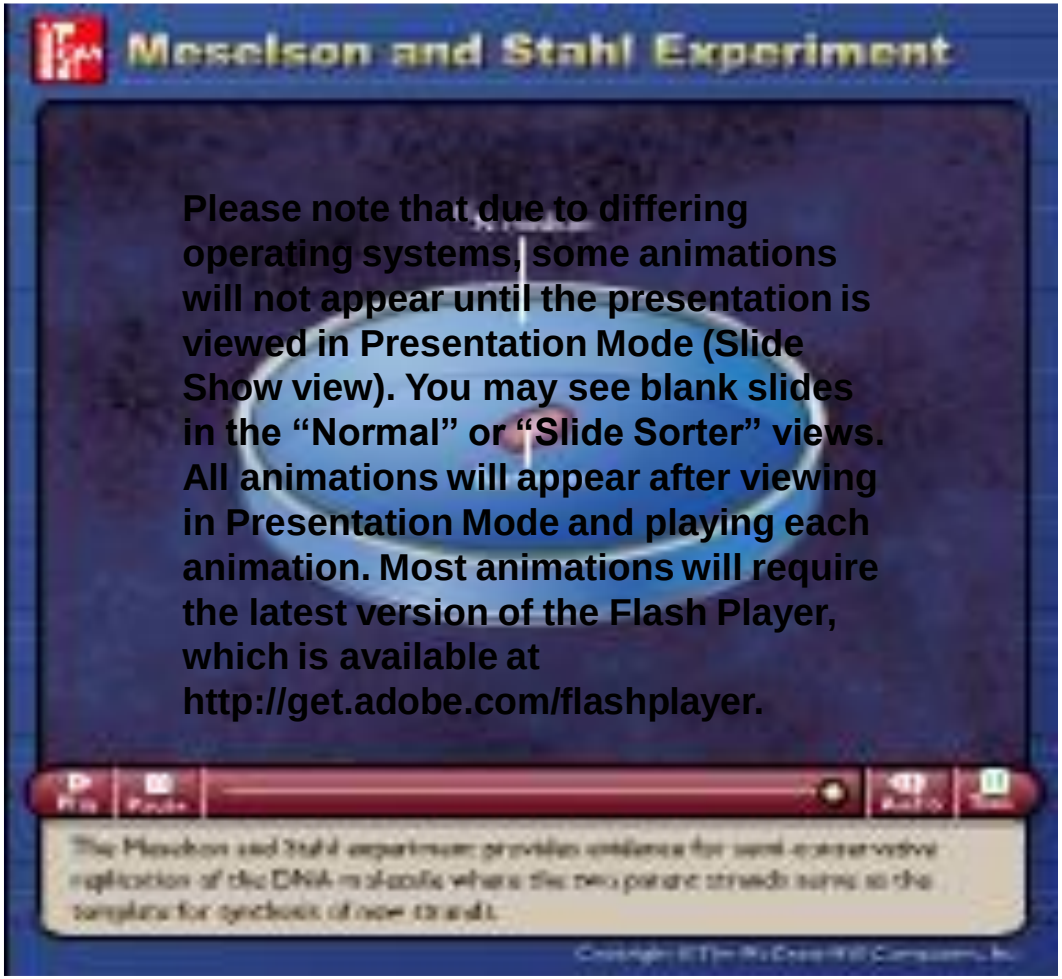
Semiconservative Replication of DNA



Animation


Meselson and Stahl Experiment
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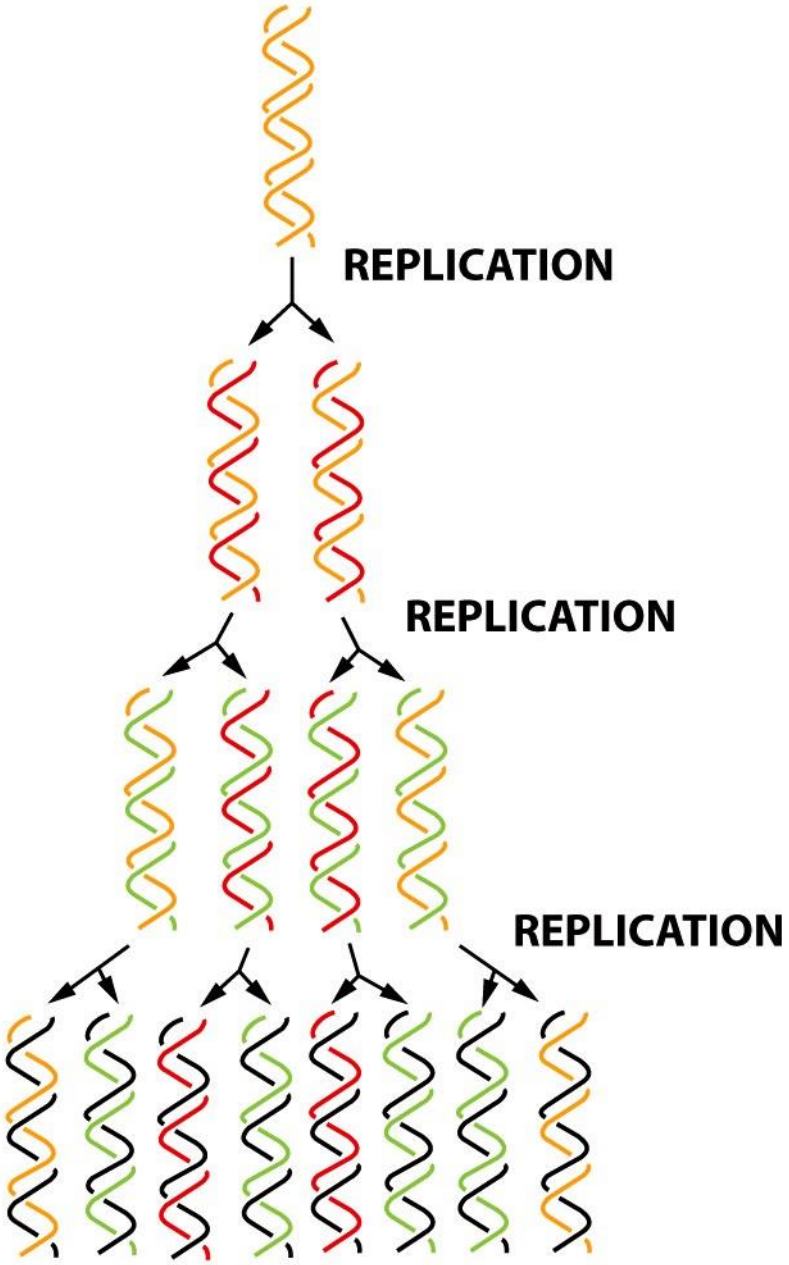
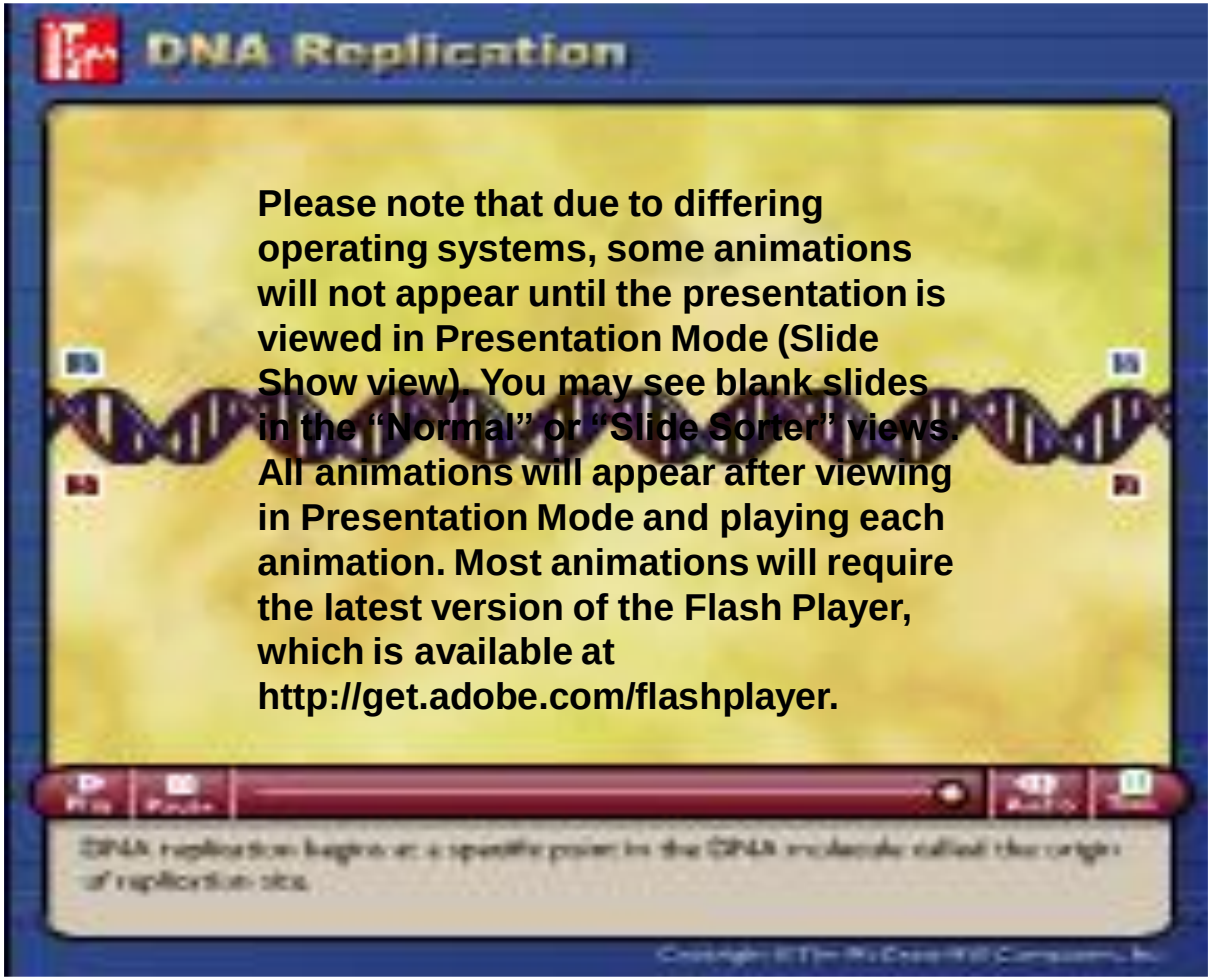
Semi-conservative replication



Each strand is used as a template for the formation of a complementary DNA strand

Figure 6-4 *Essential Cell Biology* (© Garland Science 2010)

Animation


DNA Replication
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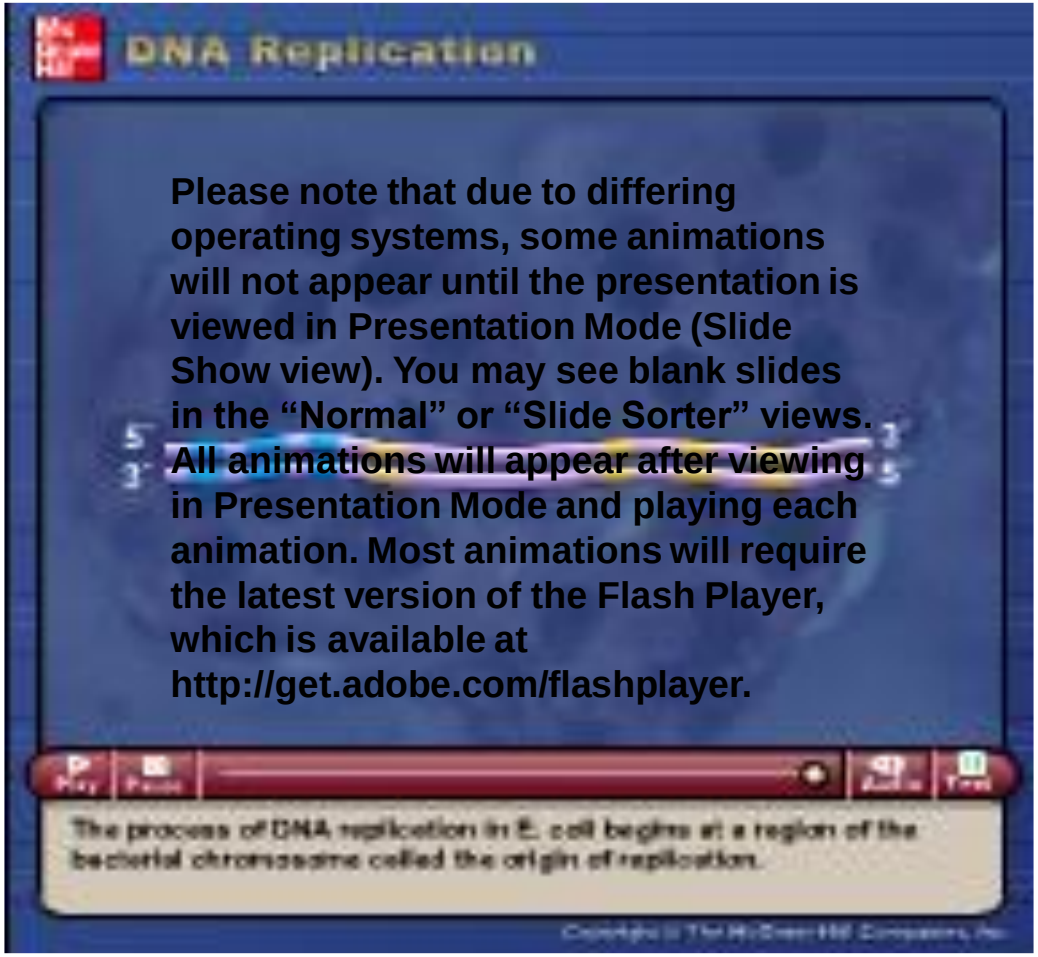
Animation


DNA Replication
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The process of DNA replication in E. coli begins at a region of the bacterial chromosome called the origin of replication.

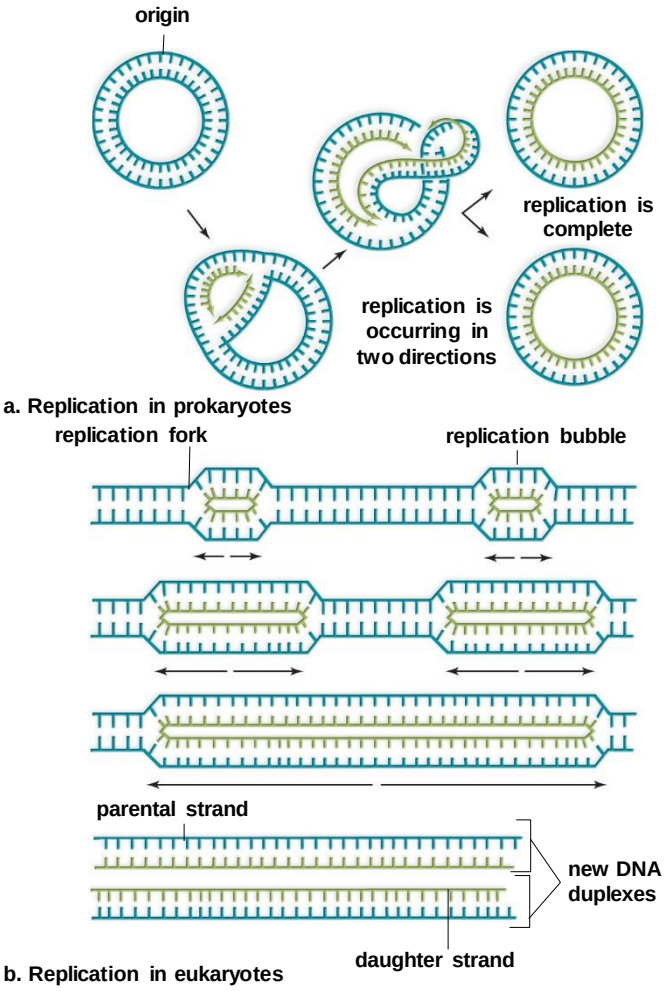
Replication: Eukaryotic

- DNA replication begins at numerous points along linear chromosome
- DNA unwinds and unzips into two strands
- Each old strand of DNA serves as a template for a new strand
- Complementary base-pairing forms new strand on each old strand
  - Requires enzyme DNA polymerase

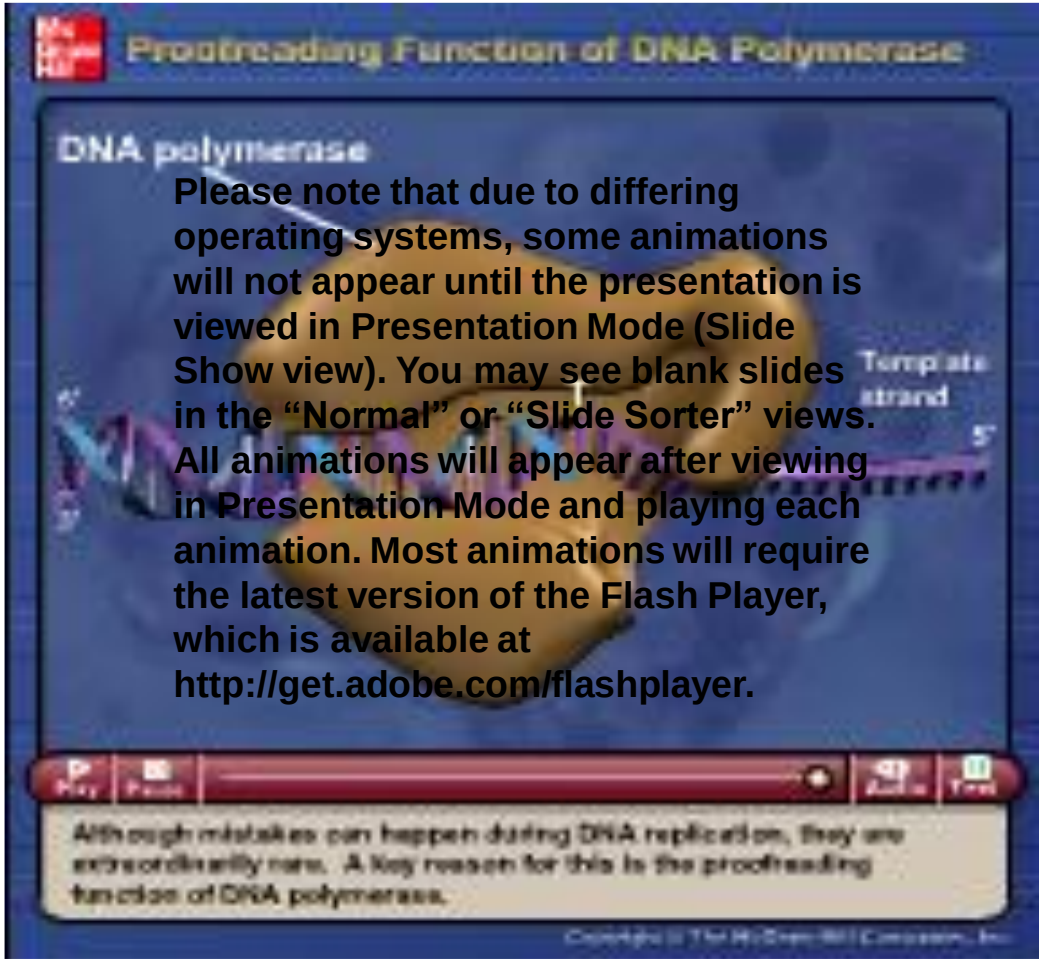
Replication: Eukaryotic

- Replication bubbles spread bi-directionally until they meet
- The complementary nucleotides join to form new strands. Each daughter DNA molecule contains an old strand and a new strand.
- Replication is semiconservative:
  - One original strand is conserved in each daughter molecule i.e. each daughter double helix has *one parental* strand and *one new* strand.

Replication: Prokaryotic vs. Eukaryotic



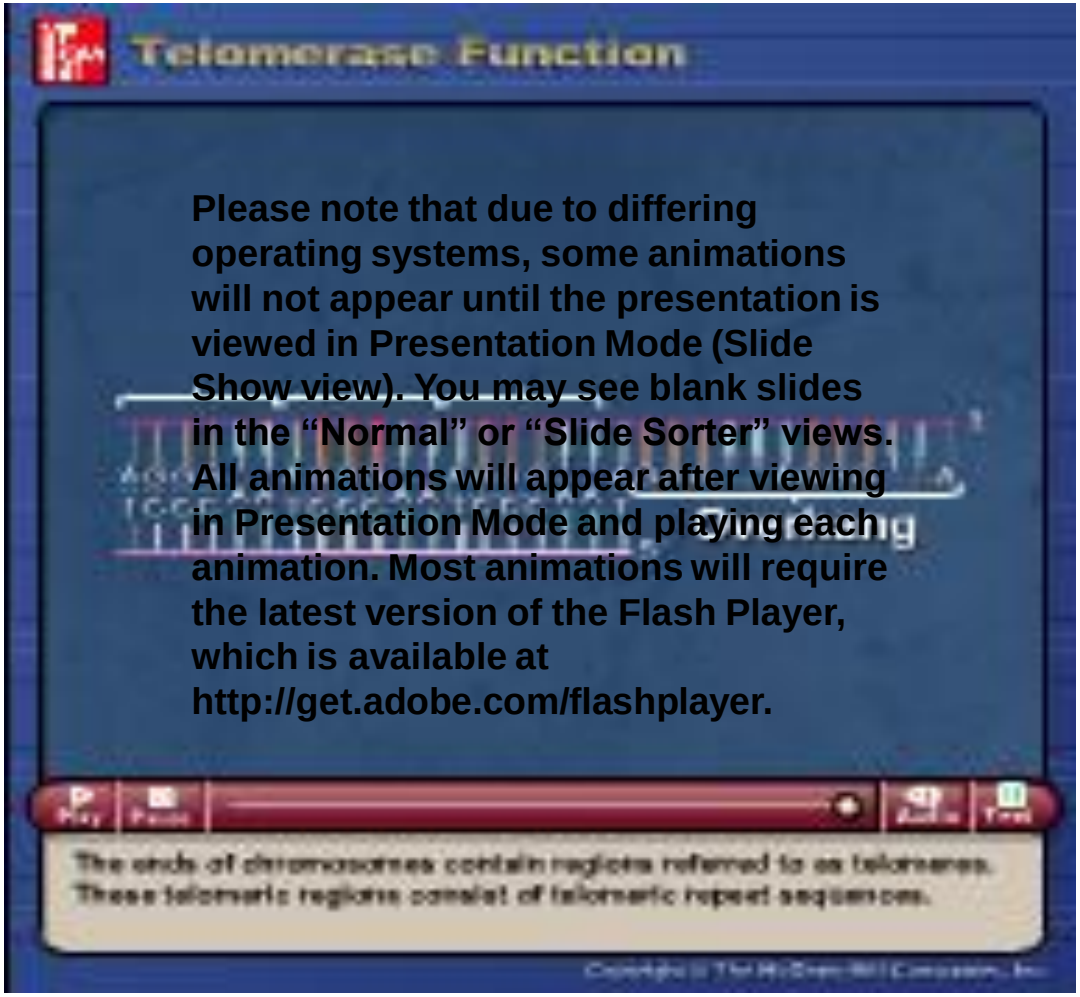
Animation


Proofreading Function of DNA Polymerase
DNA polymerase
Please note that due to differing operating systems, some animations will not appear until the presentation is viewed in Presentation Mode (Slide Show view). You may see blank slides in the “Normal” or “Slide Sorter” views. All animations will appear after viewing in Presentation Mode and playing each animation. Most animations will require the latest version of the Flash Player, which is available at http://get.adobe.com/flashplayer.
Template strand
5'
3'
Play
Pause
Although mistakes can happen during DNA replication, they are extraordinarily rare. A key reason for this is the proofreading function of DNA polymerase.

Replication: Eukaryotic

- Replication bubbles spread bi-directionally until they meet
- The complementary nucleotides join to form new strands. Each daughter DNA molecule contains an old strand and a new strand.
- Replication is semiconservative:
  - One original strand is conserved in each daughter molecule i.e. each daughter double helix has *one parental* strand and *one new* strand.

Animation


Telomerase Function
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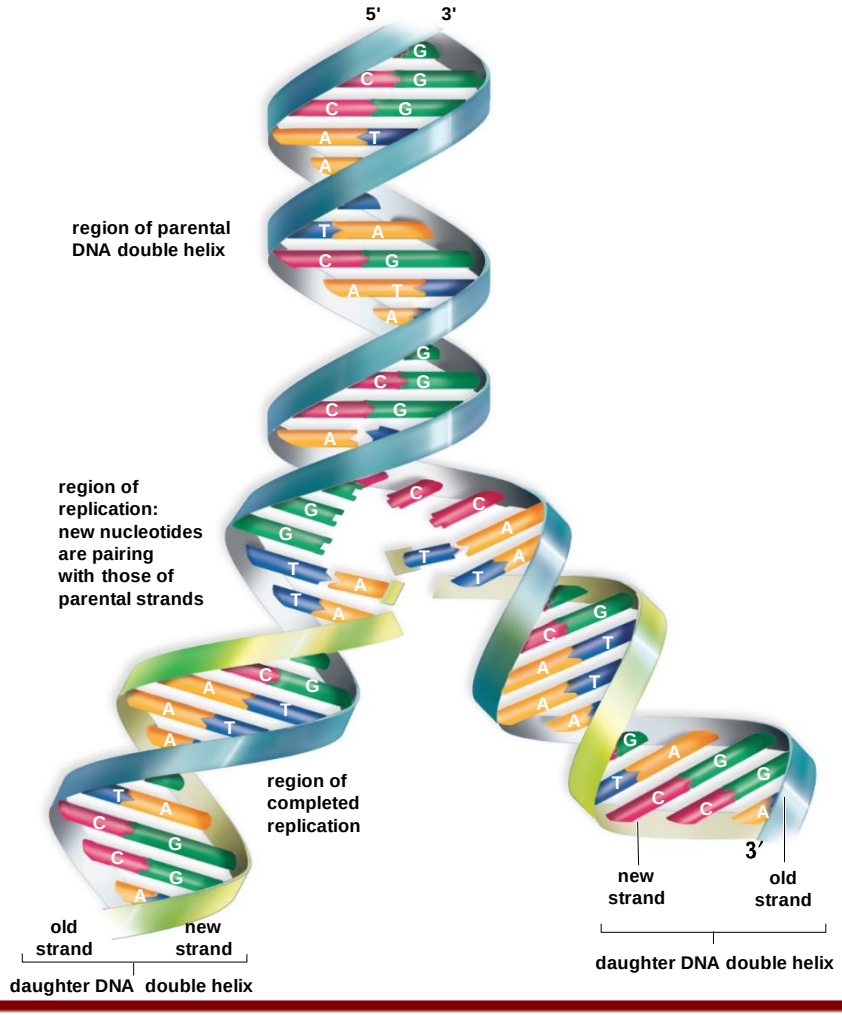
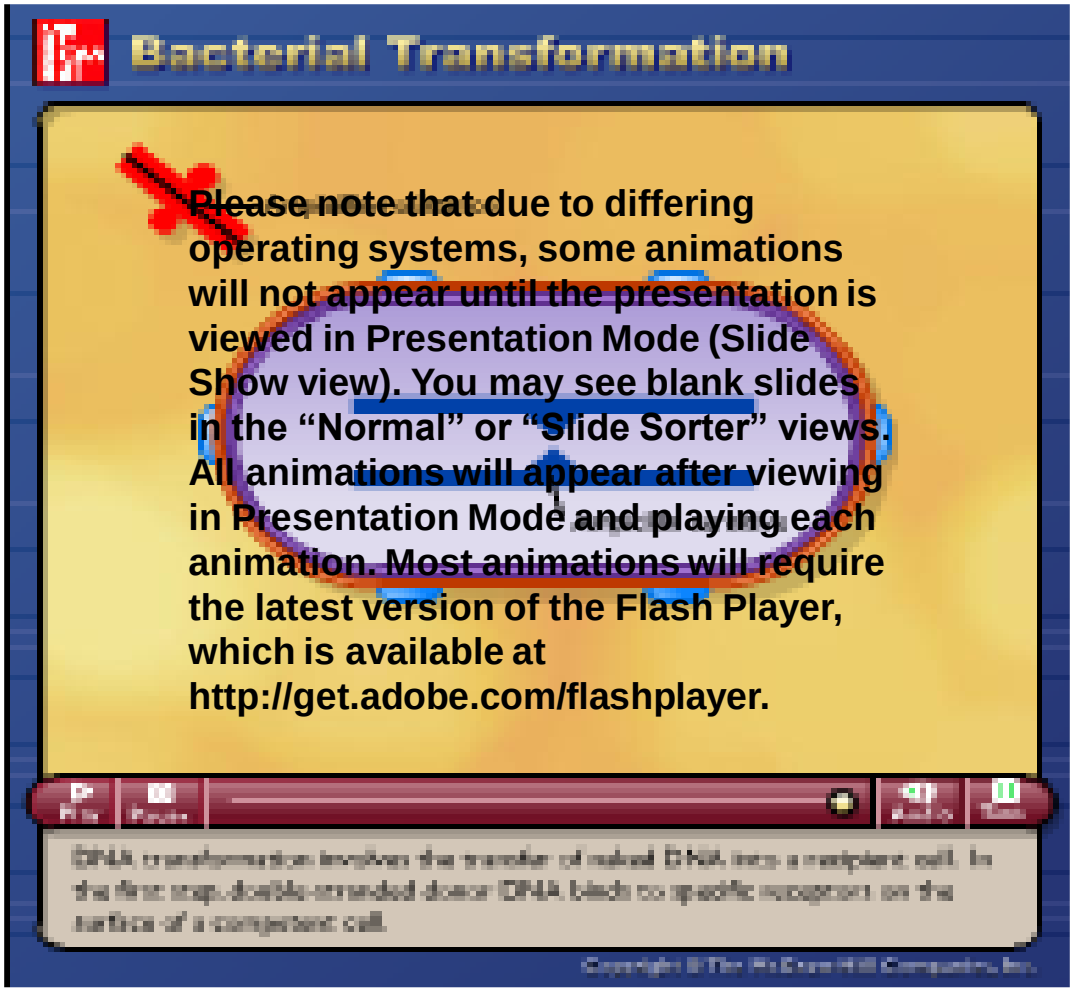
Play
Pause
Audio
Text
The ends of chromosomes contain regions referred to as telomeres. These telomeric regions consist of telomeric repeat sequences.

Semiconservative Replication of DNA



Animation


Bacterial Transformation
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https://www.youtube.com/watch?v=G1AoVF3k9Hg