CHAPTER 33
The Structure of Informational Macromolecules: DNA and RNA
Problems: 4-8, 10-11, 13-14, 19, 24-25

- **Transcription** - copying of the DNA sequence information into RNA
- **Translation** - Information in RNA molecules is translated during polypeptide chain synthesis

- **Information flow**:
  - DNA \[\rightarrow\] RNA \[\rightarrow\] PROTEIN

Reverse transcriptase (retro-viruses) Howard Temin
33:1 A Nucleic Acid Consists of Bases Linked to a Sugar-Phosphate Backbone

- Nucleic acids are polynucleotides
- Nucleotides have three components:
  1. A five-carbon sugar
  2. A weakly basic nitrogen base
  3. Phosphate
- Nucleotides are phosphate esters of nucleosides

![Diagram of nucleic acids](image-url)

**Figure 33.5** Biochemistry: A Short Course, Second Edition © 2013 W.H. Freeman and Company
Nucleotides

Adenylate
Guanylate
Cytidylate
thymidylate

deoxyguanosine 3'-monophosphate

Adenosine 5'-triphosphate

3'-dGMP
33:1 A Nucleic Acid Consists of Bases Linked to a Sugar-Phosphate Backbone

Figure 33.11a
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### TABLE 19.2  Base composition of DNA (mole%) and ratios of bases

<table>
<thead>
<tr>
<th>Source</th>
<th>A</th>
<th>G</th>
<th>C</th>
<th>T</th>
<th>A/T&lt;sup&gt;a&lt;/sup&gt;</th>
<th>G/C&lt;sup&gt;a&lt;/sup&gt;</th>
<th>(G + C)</th>
<th>Purine/pyrimidine&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em></td>
<td>26.0</td>
<td>24.9</td>
<td>25.2</td>
<td>23.9</td>
<td>1.09</td>
<td>0.99</td>
<td>50.1</td>
<td>1.04</td>
</tr>
<tr>
<td><em>Mycobacterium tuberculosis</em></td>
<td>15.1</td>
<td>34.9</td>
<td>35.4</td>
<td>14.6</td>
<td>1.03</td>
<td>0.99</td>
<td>70.3</td>
<td>1.00</td>
</tr>
<tr>
<td>Yeast</td>
<td>31.7</td>
<td>18.3</td>
<td>17.4</td>
<td>32.6</td>
<td>0.97</td>
<td>1.05</td>
<td>35.7</td>
<td>1.00</td>
</tr>
<tr>
<td>Cow</td>
<td>29.0</td>
<td>21.2</td>
<td>21.2</td>
<td>28.7</td>
<td>1.01</td>
<td>1.00</td>
<td>42.4</td>
<td>1.01</td>
</tr>
<tr>
<td>Pig</td>
<td>29.8</td>
<td>20.7</td>
<td>20.7</td>
<td>29.1</td>
<td>1.02</td>
<td>1.00</td>
<td>41.4</td>
<td>1.01</td>
</tr>
<tr>
<td>Human</td>
<td>30.4</td>
<td>19.9</td>
<td>19.9</td>
<td>30.1</td>
<td>1.01</td>
<td>1.00</td>
<td>39.8</td>
<td>1.01</td>
</tr>
</tbody>
</table>

*Deviations from cyto ratio are due to experiment variations.*

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**Base stacking (van der Waal interactions)**

*Figure 3.13  Biochemistry: A Short Course, Second Edition © 2013 W.H. Freeman and Company*

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*Figure 3.12  Biochemistry: A Short Course, Second Edition © 2013 W.H. Freeman and Company*
DNA Replication is Semiconservative: Meselson and Stahl
"Melting" of DNA

- **Melting point** ($T_m$) - temperature at which 1/2 of the DNA has become single stranded

- **Melting curves** can be followed at $\text{Abs}_{260\text{nm}}$
33:3 DNA Double Helices Can Adopt Multiple Forms

![Diagram of DNA double helices in B, A, and Z forms.](image)
DNA is “Groovy”
Compacting of DNA

Supercoiling

E. coli chromosome

Negative supercoil
Topoisomers
Topoisomerase
33.4 Packaging of DNA in Eukaryotic Cells

- **Chromatin** - DNA plus various proteins that package the DNA in a more compact form

- The *packing ratio*: difference between the length of the metaphase DNA chromosome and the extended B form of DNA is 8000-fold
Nucleosomes

- **Histones** - the major proteins of chromatin
- Eukaryotes contain five small, basic histone proteins containing many lysines and arginines: H1, H2A, H2B, H3, and H4
- Positively charged histones bind to negatively-charged sugar-phosphates of DNA
- *Nucleosome* “beads” are DNA-histone complexes on a “string” of double-stranded DNA
- Each nucleosome is composed of:
  - Histone H1 (1 molecule)
  - Histones H2A, H2B, H3, H4 (2 molecules each)
  - ~200 bp of DNA
• Packaging of DNA in nucleosomes reduces DNA length ~tenfold
DNA is packaged further by coiling of the “beads-on-a-string” into a solenoid structure.

- Achieves another fourfold reduction in chromosome length. (4 × 10 = 40 fold)
RNA-protein scaffolds in chromatin

- Chromatin fibers attach to scaffolds
- Holds DNA fibers in large loops
- May be ~2000 loops on a large chromosome
- This accounts for an additional 200-fold condensation in DNA length. (200 X 40 = 8000 fold)

Figure 33.28
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