Hello everybody, I hope this new unit is going well! This will be a very memorization and application heavy section more than math. This means this will be more like an intro bio where flashcards, re-writing and drawing figures in addition to practice problems will serve you well here!

Remember: the Tutoring Center offers free individual and group tutoring for this Genetics. Our Group Tutoring sessions will be Tuesdays from 5:15-6:15 PM at the Sid Rich basement, room 75! You can reserve a spot at https://baylor.edu/tutoring. I hope to see you there!

Keywords: Nucleic Acid, Bacteria, Chromosome, Nucleosome

**Topic of the Week:** Discovering DNA is Heritable Material (10.2)

**Deoxyribonucleic Acid:** DNA is the coiled (helical) polymer of nucleotides that encodes and stores genetic information in organisms.

**Ribonucleic Acid:** RNA is another type of nucleic acid with encoding, structural and enzymatic capabilities → for this reason, the first organisms on earth had RNA genomes!

![Figure 10.9](image.png)

Above: the structures of the ribose (5 carbon) sugar of DNA and RNA are considered above. It is most important to note that Deoxyribose sugars lack a 2’ hydroxyl group, hence “deoxy.”

**Chargaff’s Rules:** the proportion of A&T and G&C are equivalent in DNA and the total proportions add up to 100%
**Griffith’s Experiment:** virulent (S) *S. pneumoniae* was known to be deadly and non-virulent (R) was not when injected into mice.

→ Griffith “heat killed” virulent *S. pneumoniae* and mixed them with live non-virulent *S. pneumoniae*.

→ The mixture of the “heat killed”(S) and live (R) *S. pneumoniae* **kills the mice** it is injected into

**Transforming Principle:** some “transforming substance” had to have caused the change from the non-virulent to virulent *S. pneumoniae*... we now know this is **DNA**

**Avery, MacLeod and McCarty Experiment:** proved that DNA is the “transforming substance”

Used a modified version of Griffith’s experiment where digestive enzymes were applied to transformed bacteria, showing what could or could not be the transforming substance:

<table>
<thead>
<tr>
<th></th>
<th>A.</th>
<th>B.</th>
<th>C.</th>
</tr>
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<tbody>
<tr>
<td>DNase</td>
<td>X</td>
<td>DNase</td>
<td></td>
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<tr>
<td>RNase</td>
<td>RNase</td>
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<tr>
<td>X</td>
<td>Protease</td>
<td>Protease</td>
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</tbody>
</table>

**H0:** proteins are the transforming substance

**H0:** DNA is the transforming substance

**H0:** RNA is the transforming substance

<table>
<thead>
<tr>
<th>Results: Mouse Survives</th>
<th>Results: Mouse <strong>DIES</strong></th>
<th>Results: Mouse survives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not-Valid</td>
<td><strong>Valid!!!</strong></td>
<td>Not-Valid</td>
</tr>
</tbody>
</table>

**Hershey Chase Experiment:** confirm that DNA can be genetic information (*T2 Bacteriophages*)

Using radioactive molecules in the media of infected *E. coli*, showed phages had a DNA genome (the radioactivity of phage ‘offspring’ revealed the nature of heritable factor)

→ **32P:** integrates to DNA → P-labeled phage produces radioactive offspring

→ **35S:** integrates to proteins → offspring of S-labeled phage is not radioactive

**Watson and Crick’s Discovery of DNA’s 3D Structure:** Watson, Crick and Franklin discovered DNA’s structure in 1953

**X-ray Crystallography:** an electron beam is reflected in different ways when it passes through molecules → Rosiland Franklin used this to visualize the helical structure of DNA

*click the links in the underlined titles to find out more information!*
**Watson & Crick’s Discovery:** using only what they could study or build - models, X-ray diffraction patterns (from Franklin), or structural chemistry - they concluded the **Double Helical** structure of DNA

**Fraenkel-Conrat/Singer Experiment:** showed that RNA, but not DNA, could be genetic material of viruses (model → TMV)

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### Highlight #1: DNA Structure (10.3-4)

#### Nitrogenous Bases: structures bound to the ribose sugar which confer genetic code (above)
- **Purines:** Adenine, Guanine
- **Pyrimidines:** Cytosine, Thymine (DNA), Uracil (RNA)

#### Primary (linear) Structure of DNA:
- **Nucleoside:** the 5 carbon sugar and the nitrogenous base (on the 1’ carbon)
- **Nucleotide:** the nucleoside + a phosphate (\(-\text{PO}_3^2\)) group bound to the 5’ carbon
- **NTP:** nucleoside triphosphate (RNA nucleotide)
- **dNTP:** deoxy-nucleoside triphosphate (DNA nucleotide)

*2 Phosphate groups are broken off during polymerization (TP → MP)*
- **Adenosine:** dAMP (deoxyadenosine monophosphate)
- **Guanine:** dGMP (deoxyguanosine monophosphate)
- **Thymine:** dTMP (deoxythymidine monophosphate)
- **Cytosine:** dCMP (deoxycytidine monophosphate)
Secondary (helical) Structure of DNA:

**DNA Double Helix:** the helical structure of two DNA strands bound by *hydrogen bonds* between bases stabilized by *steric effects* between adjacent nucleosides (like stacked plates)

**Phosphodiester bond:** a free 3’ -OH group binds with a 5’ [-OP-O]2 via condensation reaction (loss of H2O)

**Antiparallel:** one DNA strand runs in the 5’ → 3’ direction, while the one it is bound to is 3’ → 5’

**Complementary:** this describes Chargaff’s rules, where A’s bind to T’s and G’s to C’s on opposing strands

**NOTE:** A and T have 2 H-bonds; C and G have 3 H-bonds

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Highlight #2: Chromosomal Structure (11)

**DNA Coiling:** generally ~10bp per rotation

- **Positive Supercoiling** → more than 10bp per rotations
- **Negative Supercoiling** → less than 10bp per rotations

**Topoisomerase:** enzyme that makes double-stranded cuts to relieve tension on DNA helices

**Chromatin:** the complex of DNA and proteins

- **Euchromatin:** highly condensed form of chromatin throughout the cell cycle; likely not actively transcribed
- **Heterochromatin:** loosely condensed chromatin which changes binding tightness throughout the cell cycle

**DNase Hypersensitive Site:** sites where DNA is less tightly bound

**Histones:** proteins which associate with DNA (only in eukaryotes and some archaea)

- **Five Types:** H1, H2A, H2B, H2, H4
  - **Nucleosome:** A DNA-histone complex which DNA wraps around (~150bp)
    - **Core Nucleosome:** an octamer (2 sets of) H2A, H2B, H3, H4
    - **H1 + Linker DNA:** H1 holds the DNA in place on the nucleosome and linker DNA (~50 bp) joins adjacent nucleosomes

**Histones** generally tend to express (+) charged residues (His, Lys, Arg) to attract the (-) charged phosphate backbone of DNA

→ adding methyl or acetyl groups decreases affinity of DNA for a histone

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Additional sources are the property of The National Basketball Association, McGraw Hill Biology, and NBC Universal*
**Highlight #3: Bacteria** (ch. 9 → Miles only)

Even though only Dr. Miles covers this chapter, the concepts here can be helpful for later learning or seen in genetics lab*

**Bacteria:** prokaryotic organisms characterized by a peptidoglycan cell wall and lack of a nucleus with circular DNA

**Conjugation:** bacteria may share/interchange genetic information with one another
DNA from a *donor* may be incorporated into the genome of a recipient

**Transformation:** bacteria may pick up free bits of DNA and incorporate them into their own genome (NOTE: this is very important to the discovery of DNA as the genetic material of a cell → see *Griffith Experiment* in ch. 10)

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**Week 6 Concept Check:**

1. If a strand of DNA is 34% Guanine, what is the percentage of Adenosine nucleotides?
   - a. 32%
   - b. 34%
   - c. 16%
   - d. 68%

2. A which of these histones would you *not* expect to be part of the core nucleosome
   - a. H2\textsubscript{A}
   - b. H3
   - c. H5
   - d. H2\textsubscript{B}

3. DNA is complementary and antiparallel. If one strand is 5'-ATGCATGTCAGA-3’ what would the other strand of DNA be?
   - a. 5’-TACGTACAGT- 3’
   - b. 5’-GATCATGAGA- 3’
c. 5’-ATGCATGTCA- 3’

d. 5’-TGACATGCAT- 3’

4. What would happen if DNA-associated Histones in a particular region associated with gene A were acetylated?
   a. The number of DNase hypersensitive sites would decrease
   b. More transcription of gene A would occur
   c. Post translational modifications would modify gene A products to inhibit its transcription
   d. DNA would associate more tightly with histones

5. Why would Hershey and Chase use radioactive sulfur instead of nitrogen to identify proteins?
   a. Nitrogen is present only in amino groups, but they wanted to be extra
   b. Nitrogen exists only in DNA nucleosides, so it couldn’t label proteins
   c. Sulfur destabilizes DNA strands, so it removes DNA strands from the sample
   d. Nitrogen is present in amino acid side chains and backbones, along with DNA nucleosides; Sulfur is present only amino acids Methionine and Cysteine

THINGS YOU MAY STRUGGLE WITH:

1. Chargaff’s rule is awesome, but what about in RNA? The base U replaces T, so we’d expect A=U and C=G… right? However, Chargaff’s rule doesn't necessarily apply; RNA is often single stranded (which may have looped sections), so if bases are not paired we can’t apply base pairing rules!

2. Tip for remembering purines and pyrimidines:
   a. Purines: A and G → Pretend that aggies are ‘pure’
   b. Pyrimidines: T, C, U (obviously, we do not like TCU -sic ‘em- so we would say they are “not pure,” hence not purines)

3. What is a DNase Hypersensitive site? It is a place where DNA-protein association is weak, meaning DNA is very exposed so that Transcription machinery can access it to express genes. Thus, DNA digesting enzymes would degrade this far easier than if it was tightly associated with proteins → hence, DNase hypersensitivity!

CONGRATS; You made it to the end of the resource! Again, group tutoring will be every Tuesday from 5:15-6:30 PM. You can reserve a spot at https://baylor.edu/tutoring. I hope to see you there!

Answers:

1. C
2. C
3. D
4. B
5. D

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