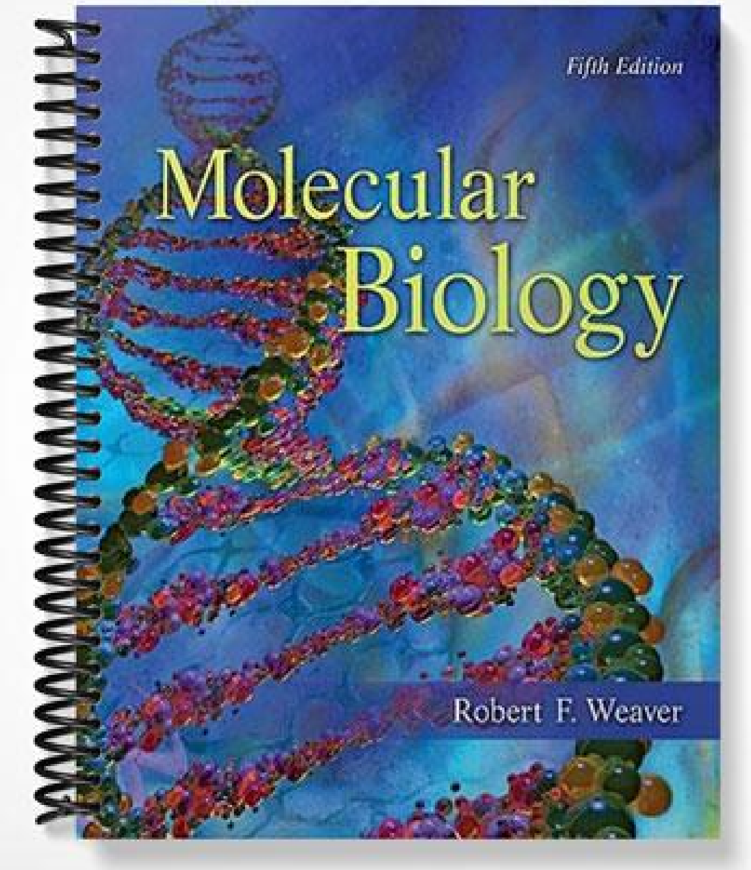
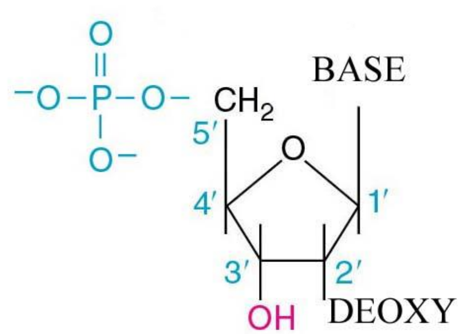
# SOLUTIONS MANUAL



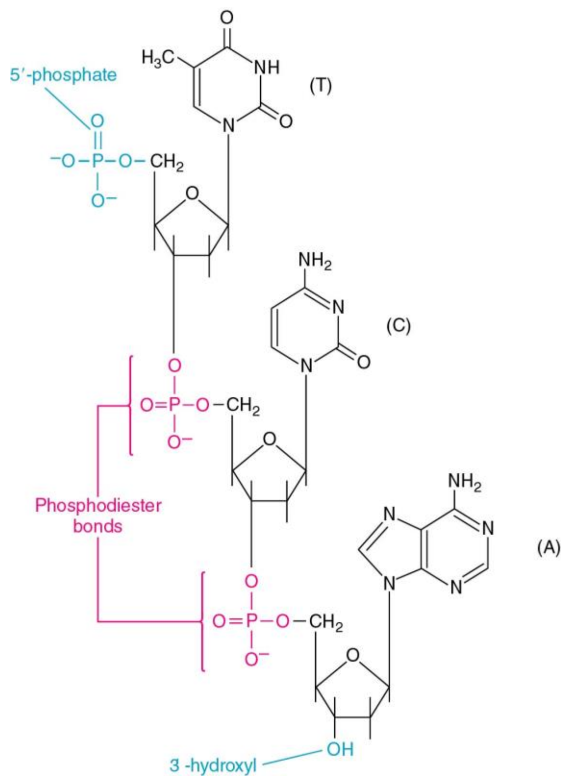
**Answers to Weaver end of chapter questions**
**Chapter 2 The Molecular Nature of Genes**

1. Avery and colleagues and Hershey and Chase chose different experimental strategies to provide evidence supporting the hypothesis that DNA is the genetic material. Avery et al. extended Griffiths' work with *Streptococcus pneumoniae* and mice using a similar transformation test. It was known that heat-killed virulent *S. pneumoniae* were capable of transforming an avirulent strain of the bacteria into a strain lethal to mice. Avery et al. demonstrated that destroying or removing (either chemically or enzymatically), the protein or RNA components of the transforming cell extract from virulent *S. pneumoniae,* had no effect on its capacity to transform avirulent bacteria. However, destroying the DNA component of the transforming cell extract did in turn destroy its ability to transform avirulent bacteria. In addition, they demonstrated that the transforming principle had the physical and chemical characteristics of DNA and not protein. In contrast, Hershey and Chase used *E. coli* and T2 bacteriophage as an experimental system. Similar to Avery et al. they differentiated between protein and DNA in their experiment. Their experiment was similarly designed to determine which component of a bacteriophage, protein or DNA, was capable of reprogramming or transforming a prokaryotic organism, specifically *E. coli*. In this way their work was similar to that of Avery et al. and aimed at refuting the commonly held belief at the time that protein is the genetic material. They took advantage of the different chemical compositions of DNA and protein to allow them to specifically label either the protein component of T2 phage with $^{35}$S methionine, or the DNA component with $^{32}$P. They removed the phage protein component from transfected *E. coli* using a blender to separate the phage ghosts attached to the outside of the *E. coli* cells from the cells themselves. Using the radiolabeling they were able to track the DNA and protein and determined that the DNA component was found within the *E. coli* demonstrating that DNA is the genetic material.

2. General structure of a deoxynucleoside monophosphate.



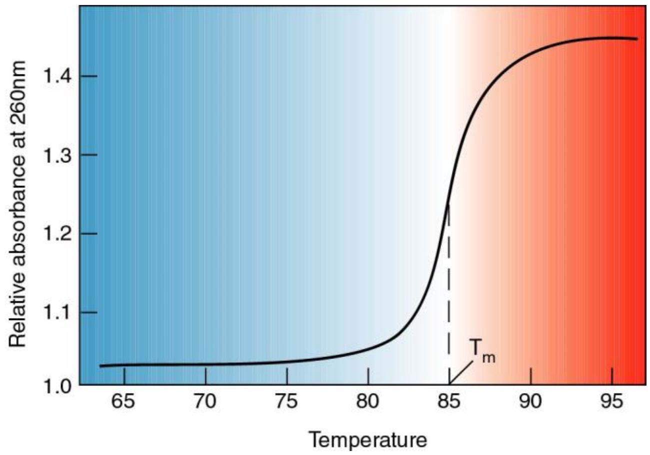
3.




4. The purine base adenine, forms two H bonds with its partner, thymine. The purine base guanine, forms three hydrogen bonds with its partner cytosine. The pyrimidine base thymine, forms two hydrogen bonds with its partner adenine. The pyrimidine base cytosine forms three hydrogen bonds with its partner guanine.

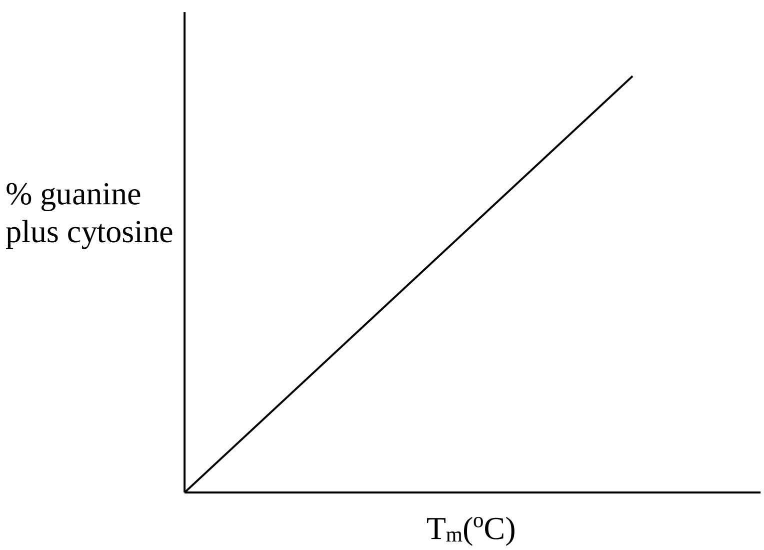
5. Base *a* is a purine (composed of a six-membered ring and a five-member ring), so we know it must be either adenine (A) or guanine (G). Furthermore, it is joined to its partner by three H bonds (dashed lines). G–C pairs are joined by three H bonds, whereas A–T pairs are joined by only two. Base *a* must therefore be guanine (G). Its partner, *b*,
must therefore be cytosine (C). Base *c* is a purine that is joined to its partner by only two H bonds. Because A–T pairs are joined by two H bonds, base *c* must be adenine (A). Its partner, *d*, must therefore be thymine (T).

6. A typical DNA melting curve.




$T_m$= Melting temperature

7. Melting temperature increases as the GC content of a DNA sample increases. This is explained by the presence of three hydrogen bonds in GC base pairs rather than two as are present in AT base pairs. The extra hydrogen bond means more thermal energy is required to separate GC base pairs than AT base pairs.

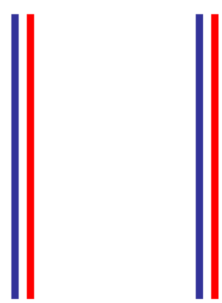


8.

Nucleic acid from source one Nucleic acids from source two

Denature double stranded DNA using heat

Incubate in conditions that favor duplex formation e.g. high salt



Double stranded hybrids

**Analytical Questions**

1.
   a. The average molecular weight of a base pair is 660 Daltons (0.660 kD). For a virus of 1.0 X $10^5$ kD the number of base pairs is the total size of the genome divided by the average molecular weight of a base pair.

      $$1 \text{ X } 10^5 \text{ kD}/0.660 \text{ kD} = 1.5 \text{ X } 10^5 \text{ bps}$$

   b. There are 10.4 bp per helical turn in a DNA molecule. The number of helical turns in a DNA molecule is therefore the length of the DNA molecule divided by 10.4 bp.

      $$1.5 \text{ X } 10^5 \text{ bps}/10.4 \text{ bp/turn} = 1.4 \text{ X } 10^4 \text{ turns}$$

   c. The spacing between base pairs is 3.32 X $10^{-4}$ μm. The length of a DNA molecule is therefore the number of base pairs multiplied by the length of a single base pair.

      $$(1.5 \text{ X } 10^5 \text{ bps}) \text{ X } (3.32 \text{ X } 10^{-4}\ \mu\text{m/bp}) = 50\ \mu\text{m}$$

2. The average protein has a molecular mass of 40,000 Daltons and the average molecular mass of an amino acid is 110 Daltons. Hence the average protein has 364 amino acids. Given that three nucleotides are required to encode one amino acid it requires at least 1092 nucleotides to encode an average protein. A viral genome of 12,000 bp will therefore be able to encode 11 proteins.