STUDY GUIDE - *Ch. 16 - DNA is the genetic material* **NAME:** _____

- **PHYSICALLY PRINT OUT this PDF and HANDWRITE (with a black or blue pen) your answers directly on this PDF.** *Typed or digitally-written work is **not** accepted. Do **not** answer questions on separate paper.*
- **Importantly, study guides are NOT GROUP PROJECTS!!!** *You, and you alone, are to answer the questions as you **read** your assigned textbook. You are **not** to share answers with other students. You are **not** to copy any answers from any other source, including the internet.*
- **Get in the habit of writing LEGIBLY, neatly, and in a medium-sized font.** *AP essay readers and I will skip grading anything that cannot be easily read so start perfecting your handwriting, and don't write so large you can't add all the relevant details and key elaborations in the space provided.*
- **SCAN physical documents in color and with good resolution. Then, upload your final work as PDFs to Archie.** *Avoid uploading dark, shaded, washed-out, sideways, or upside-down scans of homework. Keep completed physical study guides organized in your biology binder to use as future study and review tools.*
- **READ FOR UNDERSTANDING and not merely to complete an assignment.** ***First**, read a section quickly to get an overview of the topic covered. Then, read it a **second** time slowly, paraphrasing each paragraph **out loud** and analyzing every figure. Finally, read it a **third** time as you answer the study guide questions if assigned and start building your memory. Try to write answers out in your own words, when possible, and try to purposefully and accurately use all new terminology introduced.*

1. What are the **two chemical components of** (eukaryotic) **chromosomes**? *(Remember, bacterial chromosomes are **not** permanently associated with histone proteins, thought archaeal chromosomes are! That said, proteins - those involved in transcription / gene expression, DNA replication, DNA repair etc - interact regularly with all organisms' DNA)*

   1. _____ 2. _____

2. Though today we know what the genetic material is in cells - what molecule can store the instruction for determining the phenotypes of cells and organisms, **what were three reasons researchers originally believed a cell's genetic material must consist of protein?**

   1.

   2.

   3.

3. What is a **bacterial strain**?

4. Let's review Figure 16.2, which outlined the experiment conducted by Frederick Griffith on mice.
   a. What did he call the virulent strain of ***Streptoccoccus pneumoniae**?*

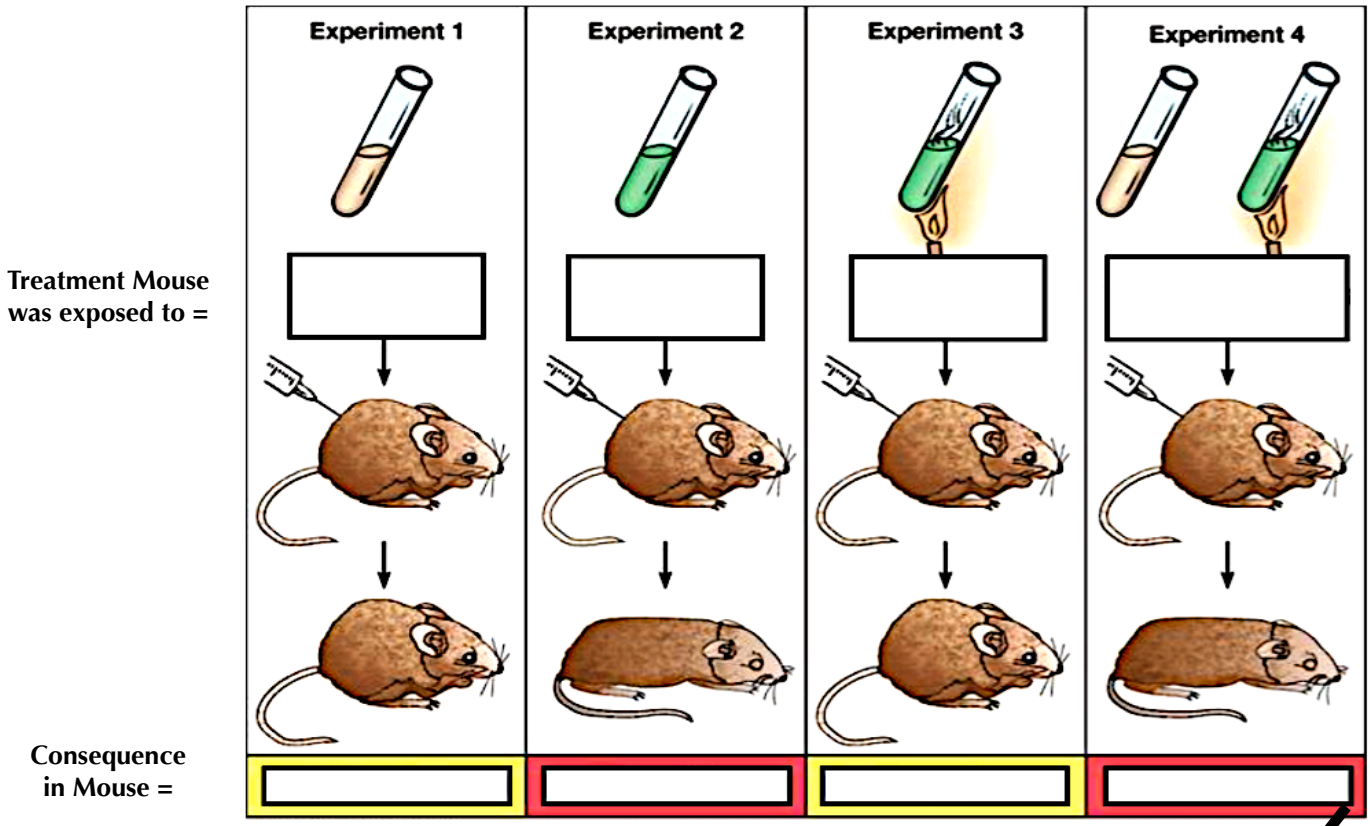
   b. Why was this strain pathogenic or virulent (able to cause disease or harm to the infected mouse)?

   c. What did he call the nonvirulent strain of ***Streptoccoccus pneumoniae**?*

   d. Why was this strain not pathogenic or virulent (not harmful to the infected mouse)?

   e. What was the **purpose of Frederick Griffith's studies**? (Why did he conduct this study?)

f. Label this figure summarizing the experiment in which Griffith became aware that **hereditary information could be transmitted between two organisms** (in this case, strains of bacteria).



g. *Think:* What result did Griffith *expect* in group 4?
*(Check your answers by going to the **Ch.16.1 Concept Check Question #2** answer in Appendix A)*

h. What **unexpected reality did Griffith actually observe in blood samples of the mice in group 4**?

i. What **conclusion did Griffith draw based on the experimental results he observed**?

j. *Think:* **How/Why** did Griffith's experiment rule out the possibility that the R cells could have simply used the pre-existing capsules of the dead S cells to become pathogenic **instead** of making their own capsules post-transformation?

5. Now that you understand the concept, define the term **transformation**? *(**Note:** When a healthy eukaryotic cell turns into a cancerous cell, we also say that the cell got "**transformed**," though this transformation is due to mutations in the DNA of the cell, not due to the cell acquiring new genes or alleles of pre-existing genes from an external source).*

*(Pssst...Check your answers to **4.j.** by going to the **Ch.16 Figure Questions** in Appendix A and reviewing the answer for **Figure 16.2**)*

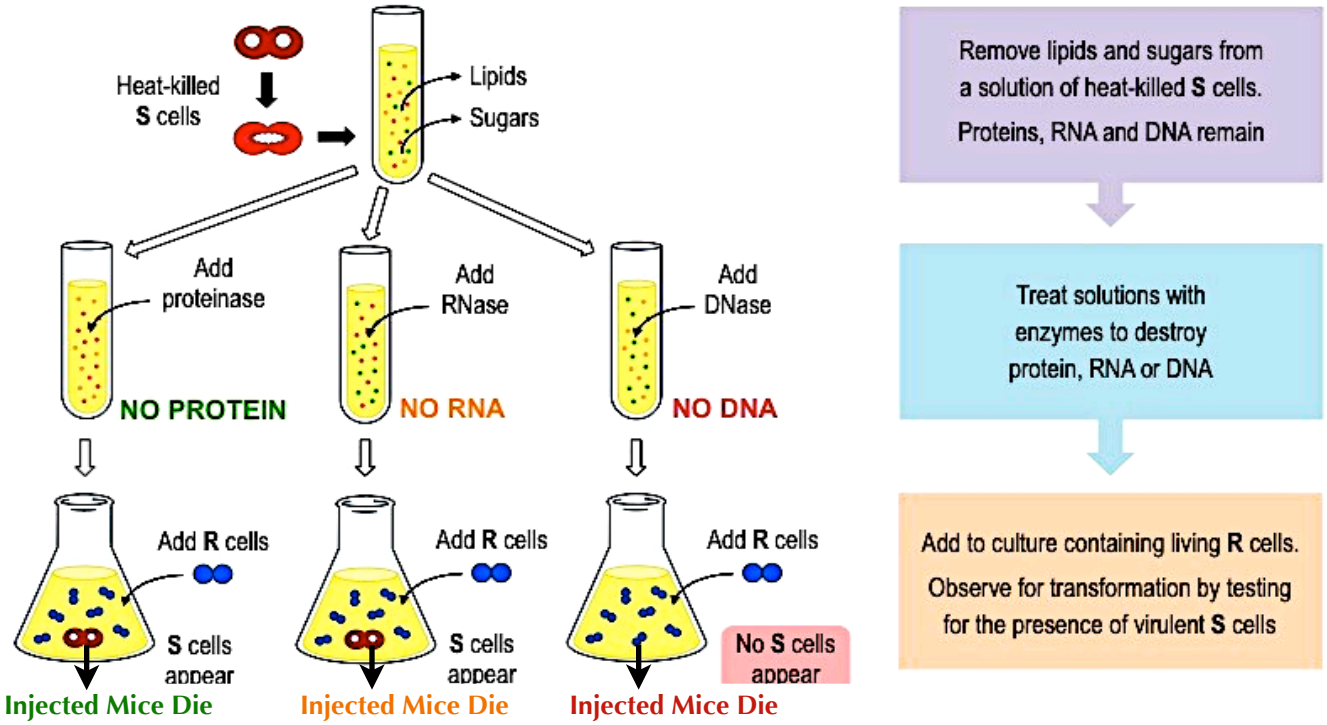
6. In 1944, Oswald Avery, Colin MacLeod, and Maclyn McCarty published the results of an experiment which indicated that _____ is responsible for bacterial transformation and, therefore, is likely to be the genetic material of bacteria.

Let's understand the experimental setup they used and the results observed that led them to their conclusion.
Before proceeding, watch the video https://www.youtube.com/watch?v=fci1oS1kofs

The experiment by **Avery, aMcLeod, and McCarty set out to identify the chemical agent that Griffith referred to as the Transforming Principle using enzymes that destroy specific polymers extracted from the virulent S. Pneumoniae strain.**

1. In the negative control group, they left the protein and nucleic acids from the harmful strain intact, exposing this mixture to nonvirulent S. Pneumoniae, which was then injected into mice in order to observe if the nonvirulent bacteria (without a capsule surrounding their cell wall) transformed into virulent ones (with a capsule) and killed the mice.
2. In the first experimental group, they used **proteases to digest the proteins of virulent pneumonia bacteria**, leaving the nucleic acids from the harmful strain intact, exposing this mixture to nonvirulent S. Pneumoniae, which was then injected into mice in order to observe if the nonvirulent bacteria (without a capsule surrounding their cell wall) transformed into virulent ones (with a capsule) and killed the mice.
3. In the second experimental group, they used **RNase to digest the RNA of virulent pneumonia bacteria**, leaving the DNA and proteins from the harmful strain intact, exposing this mixture to nonvirulent S. Pneumoniae, which was then injected into mice in order to observe if the nonvirulent bacteria (without a capsule surrounding their cell wall) transformed into virulent ones (with a capsule) and killed the mice.
4. In the third experimental group, they used **DNase to digest the DNA of virulent pneumonia bacteria**, leaving the RNA and proteins from the harmful strain intact, exposing this mixture to nonvirulent S. Pneumoniae, which was then injected into mice in order to observe if the nonvirulent bacteria (without a capsule surrounding their cell wall) transformed into virulent ones (with a capsule) and killed the mice.

Hypothesis: The genetic material of the cell is either protein or nucleic acid (DNA or RNA)



Conclusion: The results revealed that only the DNase prevented transformation of cells so they concluded that DNA was necessary for Transformation, but not RNA or protein, and so Griffith's "transforming principle" was composed of DNA.

7. a. Despite Avery, Macleod, and McCarty's work, scientists remained skeptical that DNA was the transforming factor and holder of hereditary material instead of proteins. Research work by Alfred Hershey and Martha Chase with bacteriophages, however, convinced the skeptics. What is a **bacteriphage**?

   b. In what way does a **bacteriophage transform the phenotype of an infected *E. coli* cell**?

   c. Sketch a T2 bacteriophage and **label its head, tail sheath, tail fiber, and d.s. DNA** (double-stranded DNA).

8. Explain in words the details of how a bacteriophage or "phage" can destroy a bacterial cell? *Review Chapter 19, Figure 19.5, to explain this better.* In the accompanying box, also **include a sequential labeled drawing of this process known as the Lytic Cycle.**

9. a. In their experiment, Hershey and Chase needed to "label" DNA and viral proteins so they could be distinguished. After reading the relevant section of your text, study **Figure 16.4** carefully. Then, **explain how they accomplished radioactively "labeling" either the DNA or the Proteins of bacteriophages with radioactive isotopes**.

   Type of isotope used to label bacteriophage **DNA** and **WHY** =

   Why was the isotope you mentioned above used to label bacteriophage DNA but not proteins?

Process of Labeling the DNA of Bacteriophages =

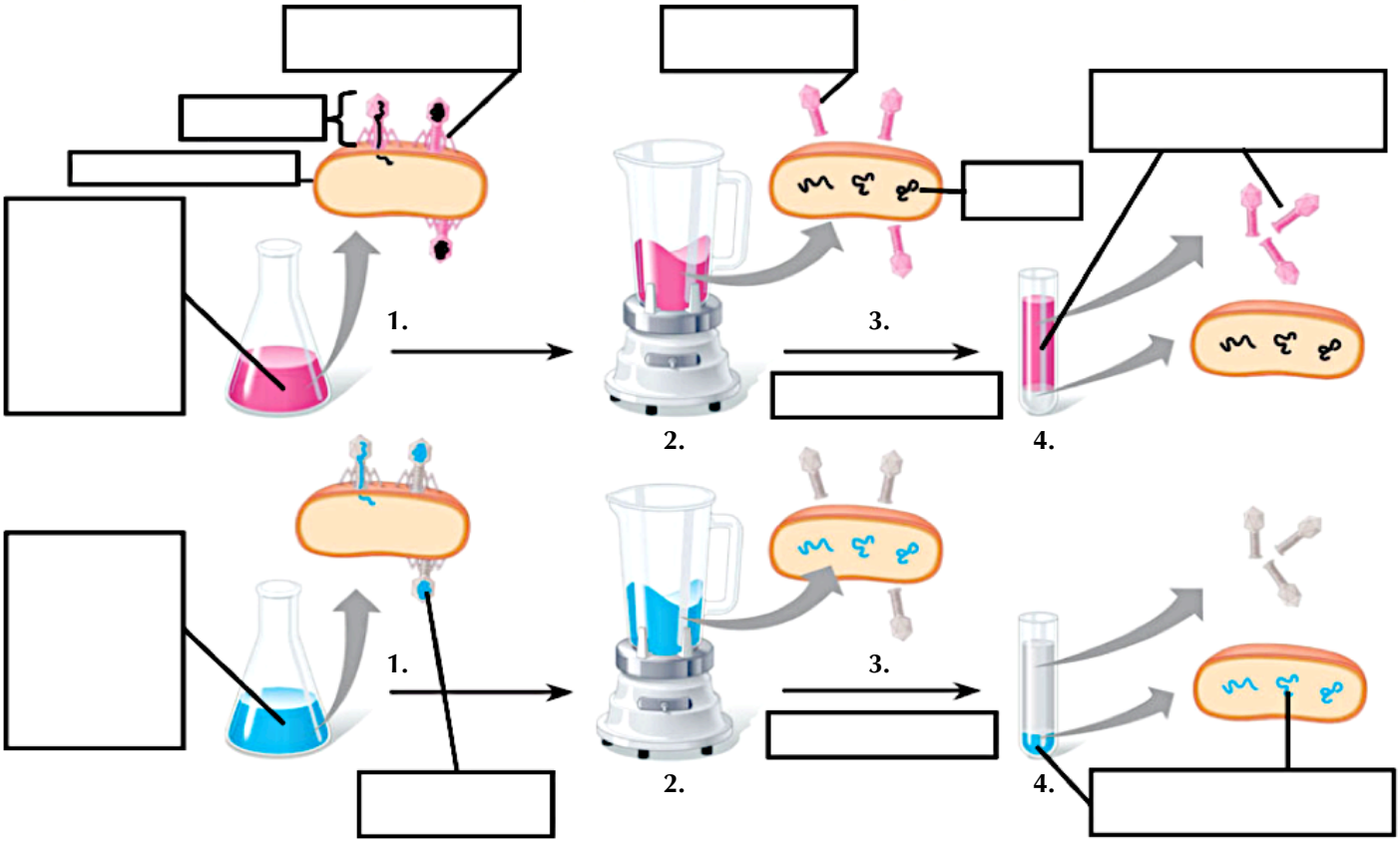
Type of isotope used to label bacteriophage **protein** and **WHY** =

Why was the isotope you mentioned above used to label bacteriophage protein but not DNA?

Process of Labeling the protein of Bacteriophages =

b. Once you have studied Figure 16.4, explain the **four main steps that made up the elegant experiment performed by Hershey and Chase** in 1952, which provided powerful evidence that nucleic acids are the hereditary material. **Label** the accompanying diagram of the experiment as well.

1.	2.	3.	4.



c. So, what were the **results** Hershey and Chase documented after conducting their experiment?

d. And, what did Hershey and Chase **conclude** based on the results observed?

e. *Think:* How would the **RESULTS** seen have been different if proteins carried the genetic information?

*(Check your answers to **9.e.** by going to the **Ch.16 Figure Questions** in Appendix A and reviewing the answer for **Figure 16.4**)*

10. List the **three components of a nucleotide**. *(Review Ch.5 Slides if you need a refresher on the structure of DNA)*

    1. _____ 2. _____ 3. _____

11. a. Erwin Chargaff work on DNA further helped convince the scientific world that DNA was the genetic material in cells. His observations on the composition of DNA in various species became known as Chargaff's rules. What are **Chargaff's rules**?

    1.

    2.

    b. **How** did Erwin Chargaff's results on the base composition of DNA from different organisms further **support the claim that DNA is the genetic material**?

12. Who built the first **accurate model of DNA** and shared the 1962 Nobel Prize for discovery of its structure?

13. Why was **Rosalind's Franklin's work** essential to the understanding of the structure of DNA? **List** all the **contributions her research made about the structure of DNA**?

14. a. **Distinguish between the structure of pyrimidines and purines**. ***Include drawings*** *of these two categories of nitrogenous bases in your descriptions.*

b. Watson and Crick's 3-D model of DNA explained the basis for Chargaff's rules. Explain the **base-pairing rule**. by discussing which nucleotides pair up between the two complimentary stands in a DNA double helix? **We say these nucleotides "base pair together" or these nucleotides "are complimentary to each other."**

c. **Explain the chemical reason the nucleotides base pair together as they do**?

15. Complete the **Scientific Skills Exercise: Working with Data in a Table**.

1. How Data Demonstrates Chargaff's Rule #1 =

How Data Demonstrates Chargaff's Rule #2 =

2. Fill in the table, show your mathematical work to the right of the table.

Source of DNA	Base Percentage			
	Adenine	Guanine	Cytosine	Thymine
Sea urchin	32.8	17.7	17.3	32.1
Salmon	29.7	20.8	20.4	29.1
Wheat	28.1	21.8	22.7	
E. coli	24.7	26.0		
Human	30.4			30.1
Ox	29.0			

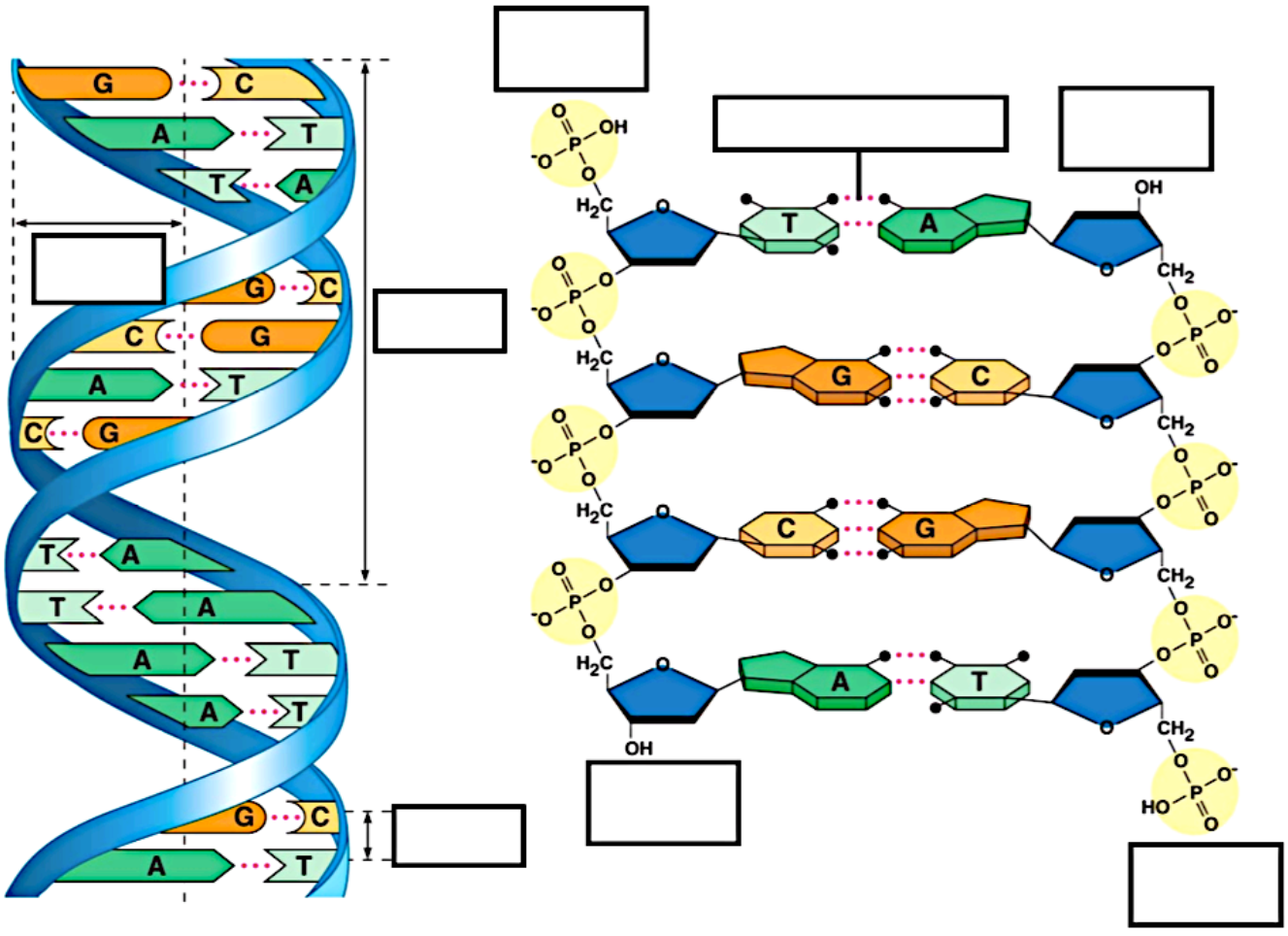
3.

16. Remember, all nucleotides of nucleic acid polymers (RNA or DNA) are composed of nitrogenous bases, but the nitrogenous bases, just like the sugar, in the nucleotides differ between DNA and RNA. **Return to Ch.5 Figure 23** and name the five nitrogenous bases, put a checkmark in the correct column below for each base, and indicate if the base is found in **DNA** (D), **RNA** (R), or **BOTH DNA & RNA** (B).

Nitrogenous Base	Purine	Pyrimidine	D, R or B

17. Read over the entirety of **Figure 16.7, Visualizing DNA**.

a. Label the illustration of DNA below.



b. Describe the structure of DNA relative to each of the following:

Diameter across the DNA molecule = _____

Components of the backbone of a DNA double helix = _____ + _____

Components of the strands of DNA = _____

c. Describe the locations and make up of the **bonds that hold together two adjacent nucleotides in one DNA strand**.

d. Compare the bonds that hold nucleotides together in 1 strand to the **bonds that hold the 2 DNA strands together**.

*(Check your answers to **17.c & d.** by going to the **Ch.16 Figure Questions** in Appendix A & reviewing answer 1. & 2. for **Figure 16.7**)*

e. How do the **two ends of one DNA strand differ in structure**? Be clear and specific, describing the **5′ and 3′ ends** of a nucleotide polymer (strand) in a DNA molecule.

f. What do we mean when we say the **two strands of DNA are anti-parallel**?

g. Mimicking the illustration of DNA on the right side in question 17.a. above, **draw a short d.s. DNA molecule** *(horizontally)* in which one strand contains the nucleotide sequence **5′ - GTAAC - 3′**. Label your bases clearly.

18. *To review:* A species of fly has DNA that consists of 35.5% adenine and 14.5% guanine. Use Chargaff's rules to deduce the the percentages of thymine and cytosine. *Explain your reasoning **in words** too; don't just show some scratch work of calculations as that is never an adequate and full explanation.*