STUDY GUIDE - *Ch. 5.5 - Nucleic Acids store, transmit, and help express hereditary information.* **NAME:** _____

- Ch. 5.6 - Genomics and proteomics have transformed biological inquiry and applications.

- **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. a. Another class of macromolecule (or organic polymer) include nucleic acids. What are the **nucleic acids**?

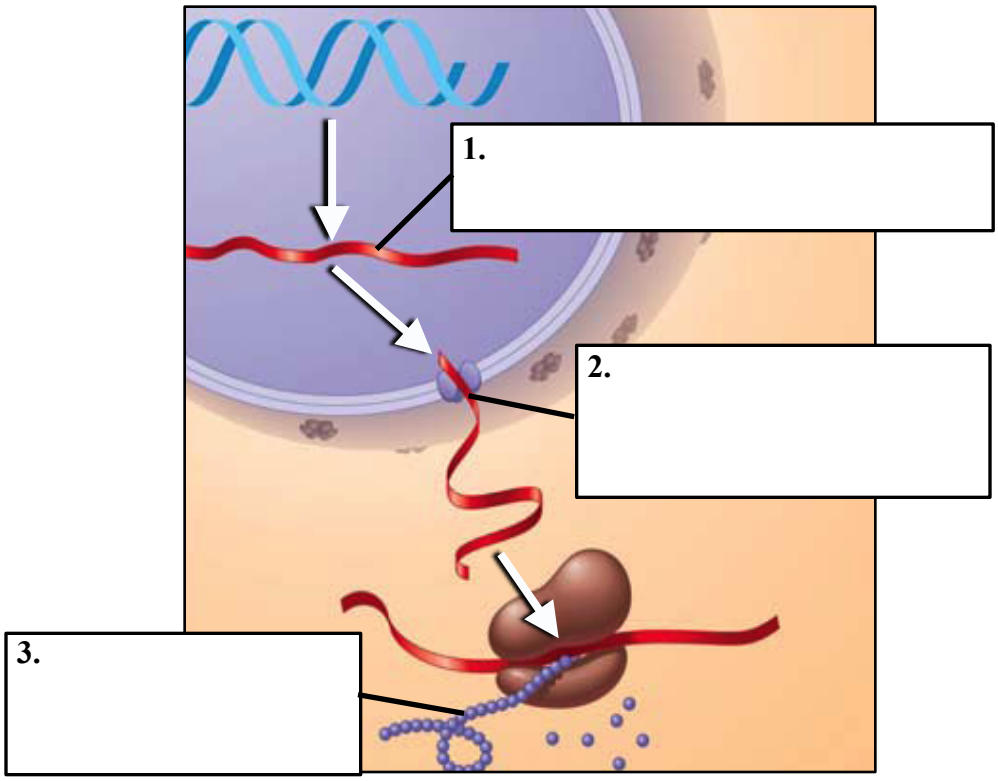
   b. Within the sequence of covalently-bonded monomers that make up a molecule of DNA (one type of nucleic acid), certain sections of the DNA polymer are referred to as genes. What is a **gene**?

2. a. What do the acronyms **DNA** and **RNA** stand for?

   b. **How is DNA**, containing **the instructions for making all the PROTEINS and RNA** (another type of nucleic acid) **molecules, passed down from generation to generation**?

3. a. When a gene ***is*** being **expressed**, the gene is considered "on," meaning the cell is actively, at that moment, constructing RNA molecules and/or proteins from the information stored in that particular gene. When a gene ***is not*** being **expressed**, the gene is considered "off," meaning the cell is not currently constructing RNA molecules and/or proteins from the information stored in that particular gene. We say that **the flow of genetic information happens from DNA → RNA → protein**. Explain what this means.

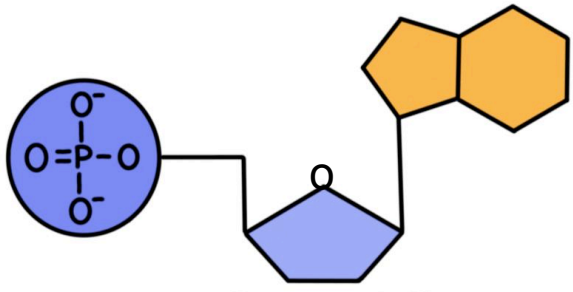
b. **Multiple types of RNA molecules exist** in the prokaryotic and eukaryotic cell, each with different functions. **Messenger RNA (mRNA)** specifically carries the information, originally found in a gene of DNA, to the polypeptide-building (and, thus, protein-building) machinery, known as **ribosomes**, inside a cell. Study Figure 5.22. Once you feel you have it memorized, label the **nucleus, cytoplasm, DNA, mRNA, ribosome, amino acids, and polypeptide** in the illustration below.



c. **In prokaryotic cells**, which lack organelles (including a nucleus), **BOTH** *RNA production and polypeptide (and, thus, protein) production take place in the cytosol of the cell.* This is not the same **in eukaryotic cells** (which house their DNA inside a membrane-bound organelle called the nucleus). *Gene expression in eukaryotes involves actions that take place both inside **and** outside the nucleus.* Fill in boxes 1-3 in the figure above in order to outline the steps in this process

4. a. **RNA and DNA molecules are polynucleotides**, polymers of monomers called nucleotides. Label the three **parts of every nucleotide**.

NUCLEOTIDE



b. Label also the **carbons of the pentose** above (1′, 2′, 3′ 4′, and 5′).

5. a. Notice that there are five different types of nitrogen bases, which can be organized into two categories. What are the **two categories of nitrogenous bases found in DNA and RNA and** how does each **differ in structure**?

I. _____ =

II. _____ =

b. Which four **nitrogenous bases are found in DNA nucleotide monomers**?

c. Which four **nitrogen bases are found in RNA nucleotide monomers**?

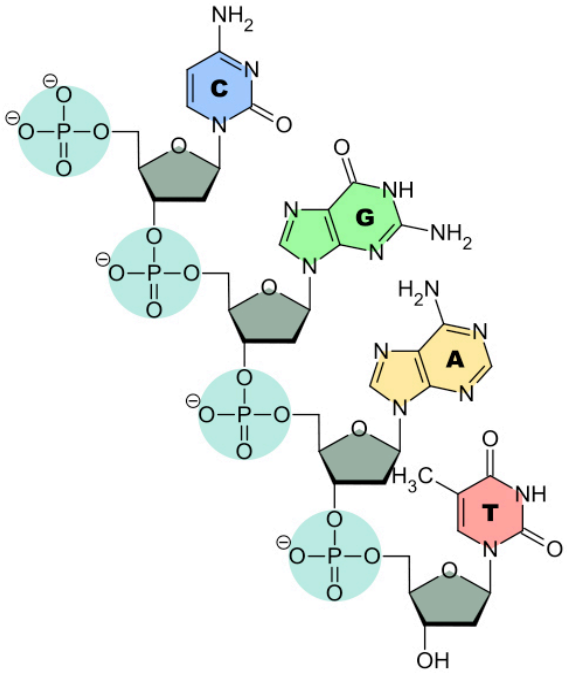
6. **D**eoxyribo**N**ucleic **A**cids (DNA polymers) and **R**ibo**N**ucleic **A**cids (RNA polymers) are both made of nucleotide monomers, though the **pentose sugar of a DNA nucleotide differs form the pentose sugar of the RNA nucleotide**. Draw a copy of the nucleotide shown in question 4.a. in each box below. The pentose sugar shown in 4.a. is missing its hydroxyl groups. Add these missing hydroxyl groups to the correct carbons in your DNA nucleotide and in your RNA nucleotide drawings.

DNA Nucleotide	**RNA Nucleotide**

7. a. Like other biological macromolecule polymers, nucleotides are covalently bonded (linked) together. What is the name of the **covalent bond that forms between nucleotides in a polynucleotide**?

b. What **chemical reaction results in the formation of this covalent linkage** between nucleotides?

c. What are the **two functional groups involved in this chemical reaction between nucleotides**?



8. a. **Nucleotides can *only* be added to the 3′ end of a polymer of nucleotides**, **not the 5′ end!!!** Label all the **phosphodiester linkages** found in the image to the right.

b. Label the **3′ and 5′ ends** of the polynucleotide strand.

c. Indicate where the sugar-phosphate backbone is as well.

9. a. Here is a model of DNA, which was proposed by James Watson and Francis Crick, the shape of this structure being called a **double helix**, it being made up of two polynucleotide **strands**. What is meant by the statement that the **two DNA strands in a double helix are antiparallel**?

b. How are **the two nucleotide strands that make up one DNA "molecule" held together in a DNA double helix**?

c. The intermolecular attractions that hold the two strands of DNA together form between the nitrogenous bases of one strand and the nitrogenous bases of the other. We say, thus, that DNA strands are **complimentary**. Which specific nitrogenous base in DNA nucleotides is able to hydrogen bond **(a.k.a. base pair)** with which other nitrogenous base in **DNA nucleotides**? (Note how the double helix of DNA exhibits the theme of **structure determining function**: the structure of the DNA, with its complementarity of nucleotide bases, allows for the molecule to transmit genetic information from one cell to a daughter cell and from one generation to the next generation).

1. _____ & 2. _____

10. Suppose a region along one DNA strand in a double helix has the following sequence of Nitrogenous Bases in the 5′ → 3′ direction:

5′ – TCGATTAGCGCGCAACTT – 3′

a. Provide the sequence of the complimentary strand. **Indicate the 5′ and 3′ ends as well, just as is shown above.** *(**Tip:** Always write the order of the complimentary bases **first**. Then, since the two DNA strands in a double helix are automatically antiparallel, add the 3′ and 5′ ends to the sequence, the 3′ end of one strand always facing the 5′ end of the other and vice versa)*

*(To see the answer to a similar question, go to **Ch.5.5 Concept Check Question #1**, and review its answer in Appendix A)*

b. RNA polynucleotides (or RNA molecules) tend to be single-stranded. However, the nucleotides of RNA (specifically the nitrogenous bases within the nucleotides) can base pair (hydrogen bond) with other nucleotides of RNA as well as with other nucleotides of DNA (even if the nucleotides' sugars are slightly different between the nucleotides of DNA and RNA). Which specific nitrogenous base in RNA nucleotides is able to hydrogen bond **(a.k.a. base pair)** with which other nitrogenous base in **RNA nucleotides**?

1. _____ & 2. _____

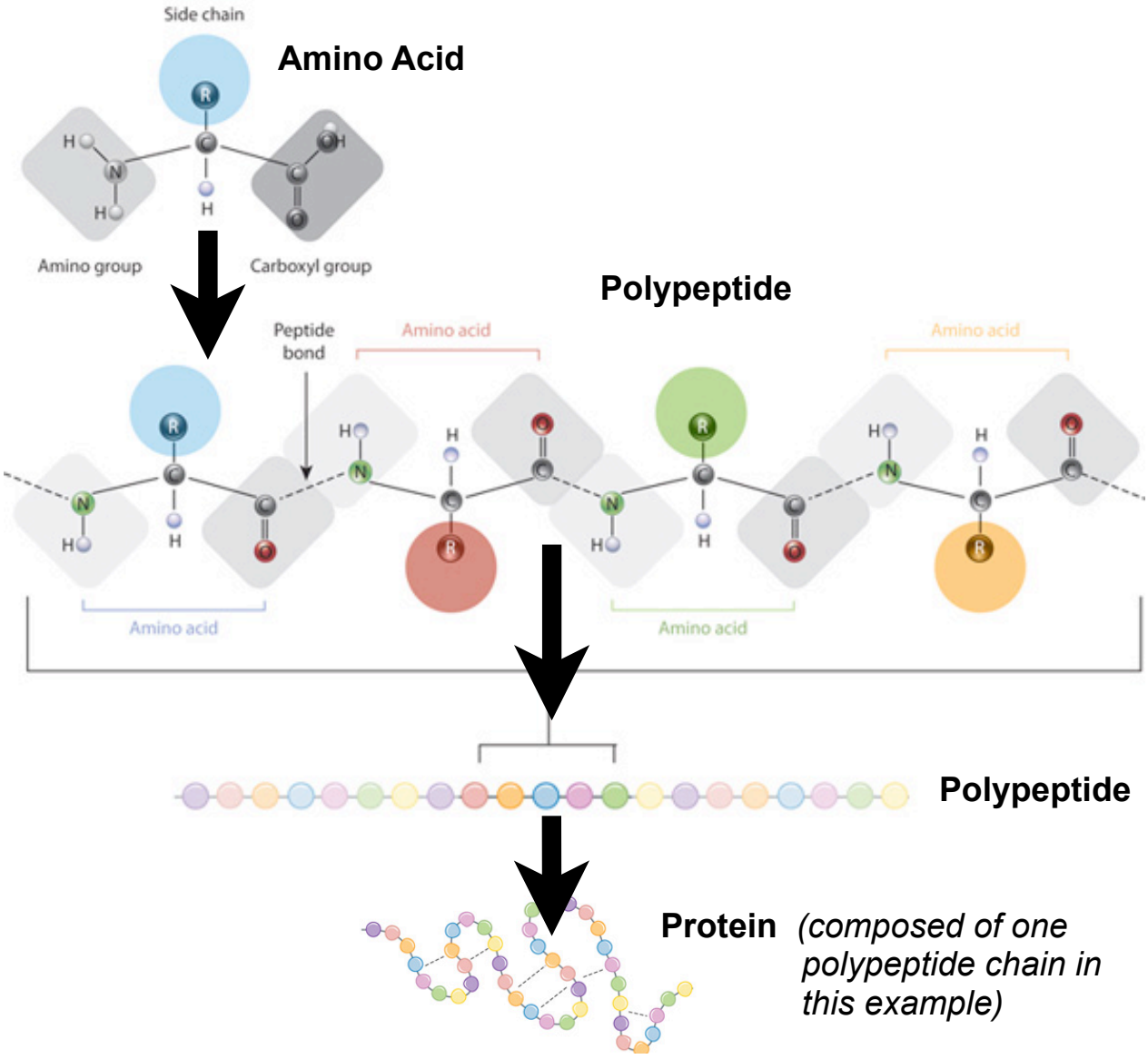
11. What are we trying to do when we **sequence DNA**?

12. What is an organisms **genome**?

13. Why do **biological siblings have a greater similarity in the primary sequence (order of amino acids) of their proteins** than non-biological siblings? *This concept applies to species that share a more recent common ancestor compared to those that are less closely related as well!*

14. Given the function of DNA, why would you **expect two species with very similar traits to also have very similar genomes** (= DNA and collection of DNA genes) *(Check your answer by going to the **Ch.5.6 Concept Check Question #2** answer in Appendix A)*

15. Remember again from Ch.5.4 that proteins are made of one or more polypeptides and that polypeptides are molecules of covalently bonded amino acids. Review the image below to review protein formation.



After you read the "Make Connections" page that highlights examples of work being done within the fields of genomics and proteomics, navigate to the Scientific Skills Exercise: "**Analyzing Polypeptide Sequence Dat**a," near the end of the chapter. Share your answers below:

1. a.

   b.

2. *(Always show your calculations).*

3. *(**Remember:** a hypothesis is an explanation, not a question).*

4. *(**Hint:** Besides proteins and their polypeptide amino acid sequence, what other sequence of monomers can be determined for two different species and then compared, the sequence of monomers in the polymer of each species being unique to each species)*

16. Test your knowledge by taking the **Self Quiz** located at the end of your chapter. *Do your best to try to answer these from memory first in order to test how well you grasped the material before. If you are unsure, return to the relevant section of your chapter and restudy any pertinent material to refresh your memory. (Check your answer by going to the **Ch.5 Test Your Understanding** answers in Appendix A)*

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____

9. **Take your time and really try to get all details right.** Being able to do so will not only help you now in Ch.5, but also future, challenging chapters like Ch.16 and Ch.17.