Name: \_\_Key\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**DNA, PROTEIN SYNTHESIS, AND MUTATIONS STUDY GUIDE**

Part A: DNA and RNA Review

1. What are the 3 main differences between DNA and RNA?

|  |  |  |
| --- | --- | --- |
|  | **DNA** | **RNA** |
| Number of Strands | 2 | 1 |
| Nitrogen Bases | Adenine, Thymine, Guanine, Cytosine | Adenine, Uracil, Guanine, Cytosine |
| Sugar Present in nucleotide | Deoxyribose | Ribose |

2. For the characteristics below, mark (A) for DNA only, (B) for RNA only, or (C) for both DNA and RNA.

\_\_A\_\_ 1. Deoxyribose sugar \_\_C\_\_ 10. Genetic Information

\_\_C\_\_ 2. Phosphate groups \_\_C\_\_ 11. Is a nucleic acid

\_\_B\_\_ 3. 3 types \_\_A\_\_ 12. Double stranded

\_\_C\_\_ 4. Nitrogen bases (G, A, and C) \_\_B\_\_ 13. Single stranded

\_\_C\_\_ 5. Nucleotide is the monomer \_\_A\_\_ 14. Function is contains instructions for making proteins

\_\_A\_\_ 6. Double helix \_\_B\_\_ 15. Function is to copy the instructions and make proteins

\_\_B\_\_ 7. Single helix \_\_A\_\_ 16. Located in the nucleus only

\_\_B\_\_ 8. Nitrogen base (U) \_\_B\_\_ 17. Located in nucleus, cytoplasm or ribosomes

\_\_A\_\_ 9. Nitrogen base (T) \_\_B\_\_ 18. Ribose sugar

Part B: DNA Replication Review

1. Why does a cell go through the process of DNA replication? To make a copy of the DNA before the cell goes through mitosis

2. Where in the cell does DNA replication take place? Nucleus

3. What part of the cell cycle does DNA replicate? S phase of interphase

4. What enzyme unwinds and unzips DNA to begin replication? Helicase

5. What enzyme brings in the new nucleotides on both sides of the DNA? DNA polymerase

6. DNA replication is described as being semi-conservative. This means that both of the copies of DNA are composed of ½ original strand and ½ new strand.

7. Using the ½ strand of DNA below, create the other ½ strand by matching the complementary bases. These are considered the parent strands. Highlight them in yellow. Now separate the parent strands and write in the new strands on both sides. Highlight the new strands in pink. These are called the daughter strands.

Parent: A T G C C C A T T T T A C C G Parent: A T G C C C A T T T T A C C G

Parent: T A C G G G T A A A A T G G C Daughter: T A C G G G T A A A A T G G C

Daughter: A T G C C C A T T T T A C C G

Parent: T A C G G G T A A A A T G G C

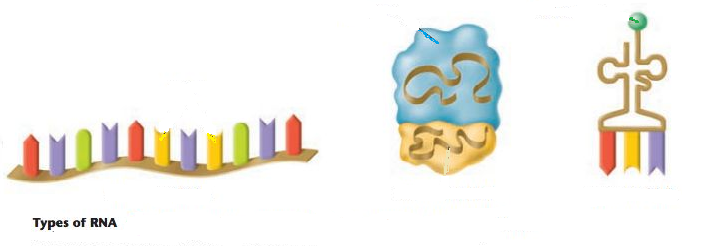
Part C. RNA

1. What are the 3 types of RNA? Label them on the pictures below.

a. Which type of RNA goes into the nucleus and retrieves the genetic information from DNA? mRNA

b. Which type of RNA makes up ribosomes? rRNA

c. Which type of RNA brings amino acids in to the ribosome while the message is read? tRNA



tRNA

rRNA

mRNA

2. Where in the cell is RNA found? Nucleus, ribosomes, cytoplasm

3. What are the 3 parts to an RNA nucleotide? Ribose sugar, phosphate group, nitrogen base (A, U, C, or G)

4. Can DNA leave the nucleus? yes

5. Why, then, do cells need RNA? To make proteins which carry out the directions initially coded in the DNA

6. What does making a protein have to do with your genetic traits coded by your DNA? It is a protein that expresses the trait coded by the DNA or carries out the directions of the DNA.

7. What is the monomer unit for a protein? Amino acid

8. What bases pair together when RNA matches up with DNA? A with U and C with G

Part D: Protein Synthesis

1. What are the two stages in protein synthesis? Transcription and Translation.

2. What happens in transcription? DNA 🡪 mRNA

3. Where in the cell does transcription take place? Nucleus

4. What enzyme aids in the production of mRNA by bringing in the RNA nucleotides? RNA polymerase

5. What type of RNA is made during transcription? mRNA

6. mRNA is divided into sets of 3 nitrogen bases called codons.

7. Put the following steps in order (1-4) for transcription:

\_\_4\_\_ mRNA leaves the nucleus with the DNA message and heads to the ribosome.

\_\_2\_\_ RNA nucleotides enter the nucleus and RNA polymerase attaches the complementary nucleotides to the DNA.

\_\_1\_\_ DNA unwinds and unzips inside the nucleus.

\_\_3\_\_ A single strand of mRNA is created and then edited, removing introns and putting exons together.

8. Once the RNA segment is created and detaches where does it go? Leaves the nucleus, travels through the cytoplasm to a ribosome.

9. Using the following segment of DNA create an mRNA strand:

DNA segment: CGA TTA CGG CTT AAG CTA

mRNA segment: GCU AAU GCC GAA UUC GAU

10. Where does translation occur? Ribosome

11. What is the end goal of translation? To make a polypeptide chain (protein).

12. What is the codon that starts the process of translation? What is the name of its corresponding amino acid?

AUG methionine

13. What are the three stop codons that terminate translation? UGA UAA UAG

14. What type of RNA brings the amino acids to the growing polypeptide chain? tRNA

15. What are the 3 bases on this molecule called? anticodon

16. Put the following steps in order (1-5) for translation:

\_\_2\_\_ mRNA is pulled through the ribosome and the message is read one codon at a time.

\_\_3\_\_ tRNA comes into the ribosome (carrying an amino acid) and its anticodon matches up to the codon on mRNA.

\_\_1\_\_ mRNA attaches to the ribosome.

\_\_4\_\_ Amino acids are linked together, beginning with the start codon and ending with one of the stop codons.

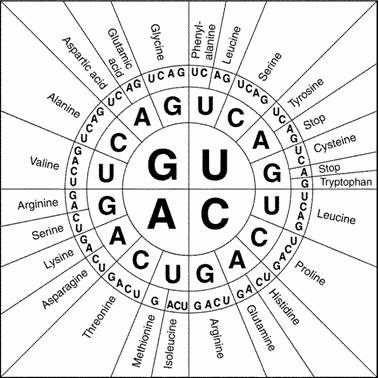
\_\_5\_\_ A polypeptide chain (protein) is made and leaves the ribosome to go golgi bodies to be folded/packaged.

17. Using the mRNA strand created above, divide it into codons, and tell what tRNA anticodons would be used to bring amino acids to this molecule. Then, use the codon chart on the next page to translate the message into the correct order of amino acids.

mRNA segment from above: GCU AAU GCC GAA UUC GAU

tRNA anticodons: CGA UUA CGG CUU AAG CUA

Amino acids: Alanine-Asparagine-Alanine-Gutamic Acid-Phenylalanine-Aspartic Acid



Part E: Mutations

1. Fill in the following concept map using the following terms: Gene, Translocation, Point, Deletion, Duplication, Chromosome, Frameshift, Inversion, change, substitution, silent, insertion, deletion.

**Mutations**—A change in the DNA

Chromosome Abnormalities/Mutations- affects large portions of DNA

Gene Mutations- a change in a small DNA sequence

Point Mutations- DNA is incorrect on only one location due to the substitution of a base. If the substitution does not code for a different amino acid, these are sometimes called silent mutations.

Frameshift Mutations- the addition or deletion of a single base changes the reading of all DNA triplets.

Deletion- a portion of a chromosome is missing

Inversion- a portion of the chromosome is turned around

Translocation- a portion of a chromosome has incorrectly attached to another chromosome

Duplication- there is too much of a portion of a chromosome

Insertion when a base is added

Deletion when a base is removed

2. Gene Mutation Examples:

|  |
| --- |
| **Original DNA Sequence**: T A C A C C T T G G C G A C G A C T  **mRNA Sequence:** A U G U G G A A C C G C U G C U G A  **Amino Acid Sequence:** Met – Tryp- Asp - Arg - Cys - Stop |

|  |
| --- |
| Mutated DNA Sequence #1: **T A C G A C C T T G G C G A C G A C T**  What’s the mRNA sequence? (Circle the change) A U G C U G G A A C C G C U G C U G A  What will be the amino acid sequence? Met – Leu – Glut. Acid – Pro – Leu – Leu - A  Will there likely be effects? yes  What kind of mutation is this (insertion, deletion or substitution)? Was it frameshift mutation, silent, or neither? |

|  |
| --- |
| Mutated DNA Sequence #2: **T A C A C C T T A G C G A C G A C T**  What’s the mRNA sequence? (Circle the change) A U G U G G A A U C G C U G C U G A  What will be the amino acid sequence? Met – Tryp- Asp - Arg - Cys - Stop  Will there likely be effects? No  What kind of mutation is this (insertion, deletion or substitution)? Was it frameshift mutation, silent, or neither? |

|  |
| --- |
| Mutated DNA Sequence #3: **T A C A C C T T G G G A C G A C T**  What will be the corresponding mRNA sequence? A U G U G G A A C C C U G C U G A  What will be the amino acid sequence? Met – Tryp – Asp – Pro – Ala - GA  Will there likely be effects? Yes  What kind of mutation is this (insertion, deletion or substitution)? Was it frameshift mutation, silent, or neither? |

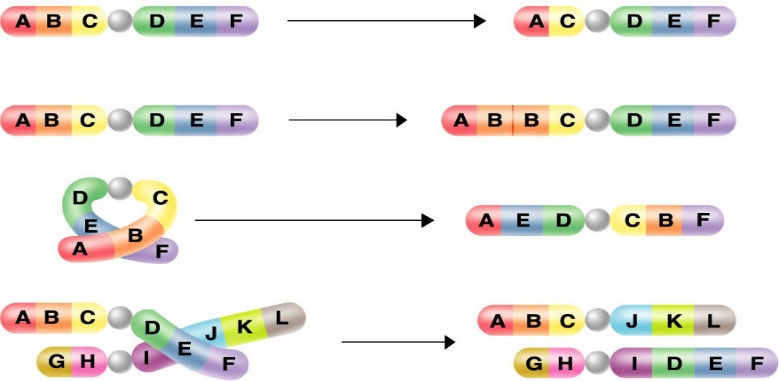
3. Chromosome Mutation Examples: What types of chromosome mutations are shown below?

Deletion

Duplication

Inversion

Translocation



4. A picture of chromosomes taken from an organism’s cells is called a karyotype.

5. When multiple copies of chromosomes are present in plants, resulting in large fruits, it is called polyploidy.

6. When only one chromosome of a pair is present in a person’s cells, it is called a monosomy of that pair.

7. When three copies of a chromosome are present in a person’s cells, it is called a trisomy of that pair.

8. A person should have 46 chromosomes, or 23 pairs.

9. The sex chromosomes are X and Y.

10. The other chromosomes (pairs 1 – 22) are called autosomes.



11. Look at the karyotype to the right and answer the questions below.

12. Is this individual a male or a female? female

13. Is there an abnormality in this individual? If so where? Yes, # 18

14. What is this kind of abnormality called? Trisomy 18

15. Is this mutation affecting a small or a large portion of DNA? Large

Part F: Prior Knowledge

1. Haploid vs. Diploid

|  |  |  |
| --- | --- | --- |
| Species Name | # of chromosomes in diploid cells  2n | # of chromosomes in haploid cells  n |
| Human | 2n = 46 | n = 23 |
| House Fly | 2n = 12 | n = 6 |
| monkey | 2n = 42 | n = 21 |
| Bat | 2n = 44 | n = 22 |

2. Place the stages of division in order:

Telophase Metaphase Prophase Anaphase

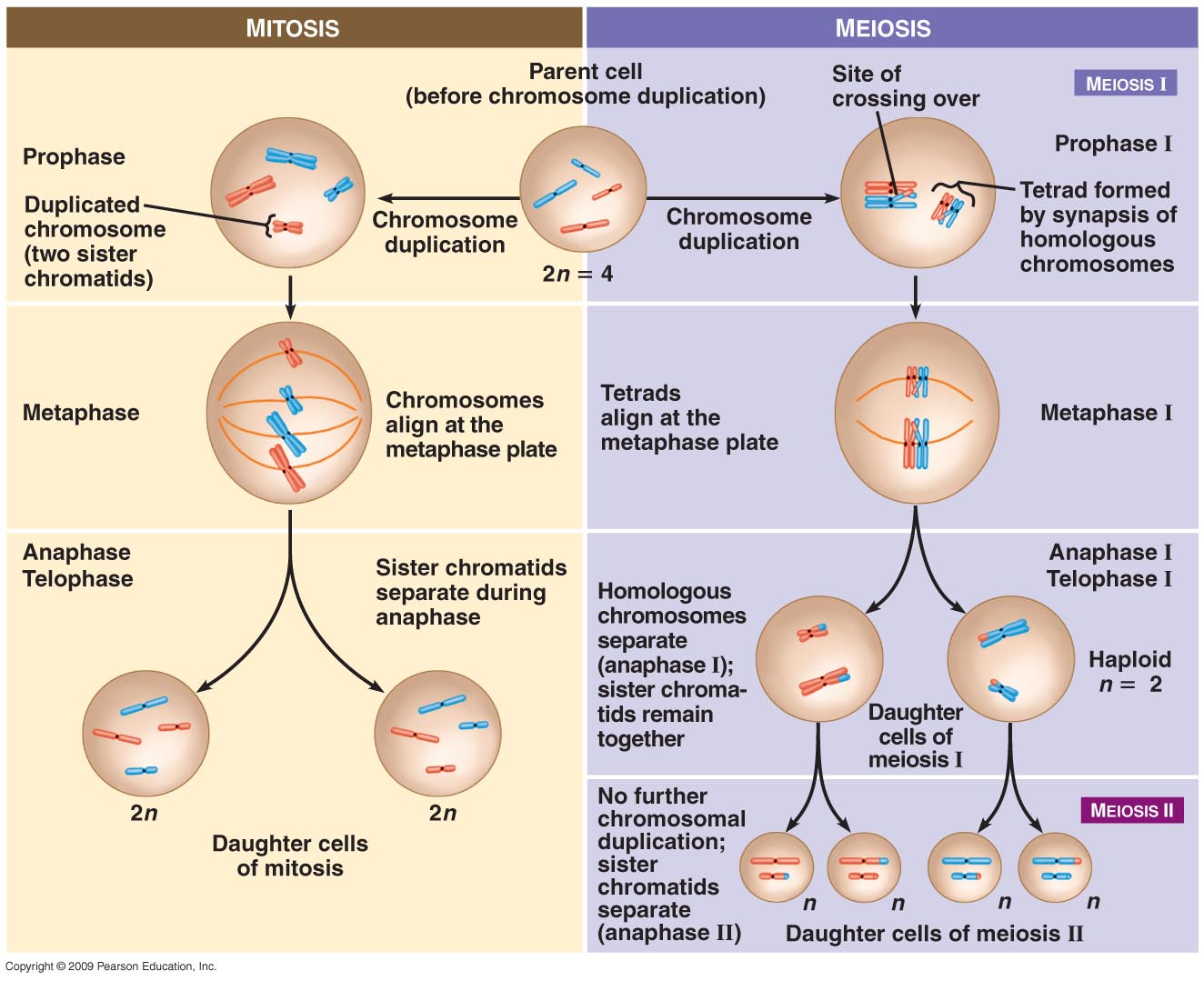
Cytokinesis



3. Do the stages above represent mitosis or meiosis, how did you know?

Mitosis, there are four stages instead of 8, which you would see in meiosis. There are also no tetrads in prophase to

indicated prophase I



Part H: Epigenetics

1. What is epigenetics? How genes can be turned on and off to control gene expression in living organisms by chemical compounds.

2. How does the packing of DNA impact its expression? Tightly packed chromatin (Heterochromatin) is not easiliy accessible and therefore not transcribed. Euchromatin is less densely packed and so it is accessible for transcription.

3. What is methylation? The binding of methyl groups to the DNA, blocking transcription.

4. What is acetylation? Attachment of acetyl groups which allows the DNA to unwind.

5. What is genomic imprinting? Turning off of genes from either the mother or the father, so only one is expressed. Ex) Girls have two X chromosomes one will be inactivated.

6. How can individuals that are twins with genetically identical DNA experience different medical conditions? Environmental exposure and different chemical compound expression (epigenome) can impact how genes are expressed.

7. How is a promoter different from an enhancer in terms of gene expression? The promoter allows the RNA polymerase and other transcription factors to attach to the DNA for transcription to occur. An enhancer will increase the rate of transcription.