



Part 1: DNA & Protein Synthesis

1. What is the shape of the DNA molecule called?

DNA: Identify the following parts of DNA using the Structure of DNA Diagram:

2. Nucleotide _____

3. Nitrogen Base _____

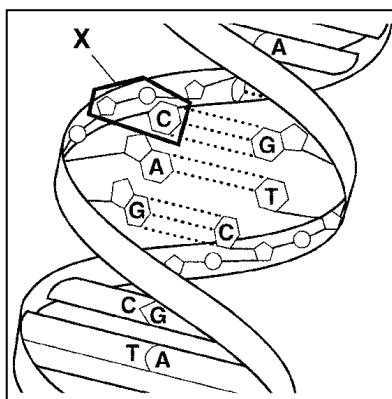
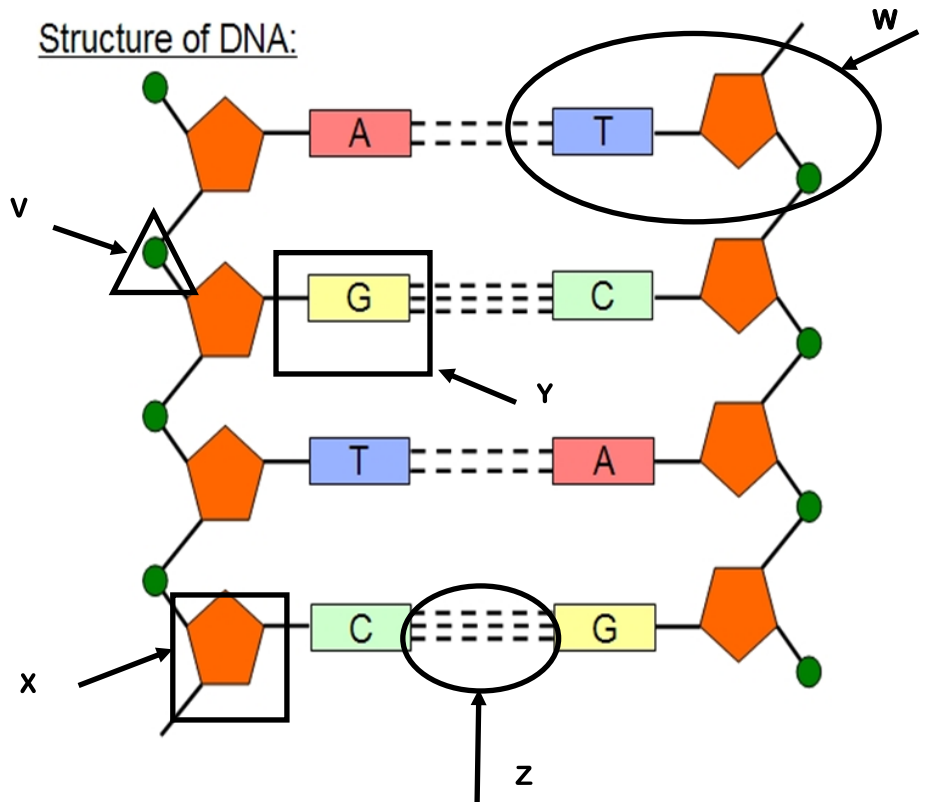
4. Phosphate _____

5. Hydrogen Bond _____

6. Deoxyribose Sugar _____

7. Which structures make up the DNA backbone?

Structure of DNA:

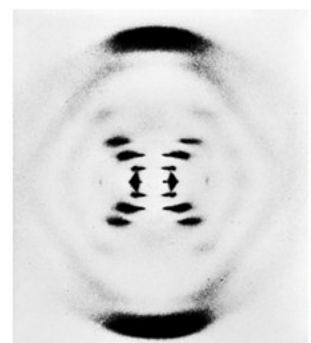


8. The structure labeled X in the diagram above represents a —

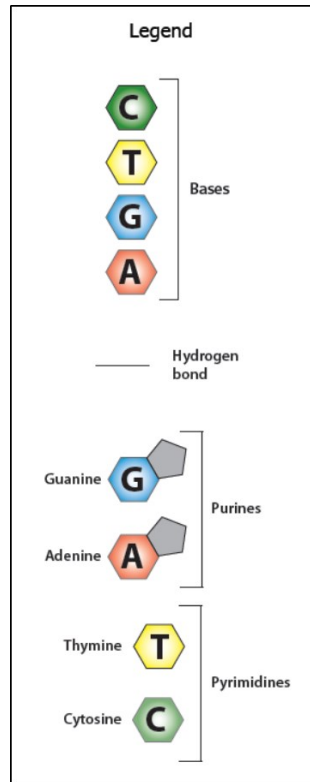
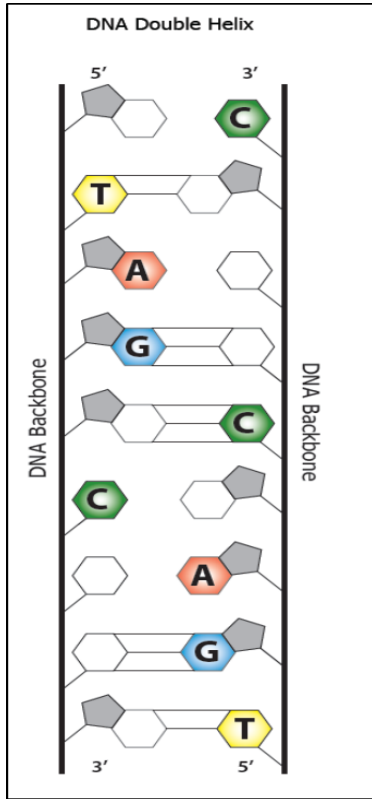
- A phosphate group
- B nitrogen base
- C sugar
- D nucleotide

9. In 1952 Rosaline Franklin took the x-ray photograph shown, which gave the world its first look at DNA. By studying this photograph, scientists gained knowledge about the —

- A role of DNA in protein synthesis
- B mutation of nucleotide sequences in DNA
- C sequence of DNA that makes up the human genome
- D double-helix structure of DNA



10. Fill in the DNA double helix. Include the **complementary bases** and **hydrogen bonds**. Use the legend to guide you.



11. How does the structure of DNA make it possible for traits to be passed on from one generation to another?

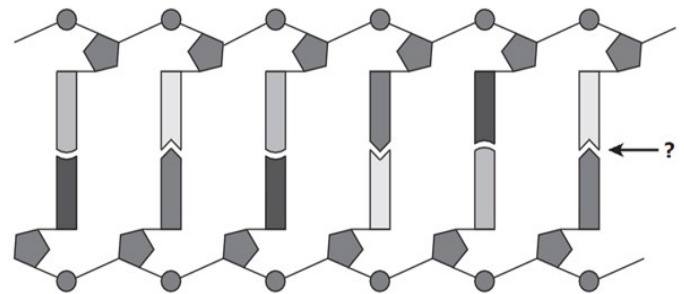
12. A model of DNA is shown below. The arrow indicates —

A the bond between adjacent phosphate and deoxyribose molecules

B the junction of introns and exons in the sense strand of DNA

C the hydrogen bonds between complementary nucleotides

D the junction of a codon and a DNA triplet



Protein Synthesis: Use the Codon Chart to the left to answer the questions about the protein synthesis process.

13. How many bases are needed to make a codon?

14. How many codons are in this DNA strand: 5' ATGCGCATT 3'?

15. Write the complementary strand of DNA

16. Change DNA 5' ATGCGCATT 3' to mRNA:

17. List the Amino Acids for the mRNA above:

Mutation Practice: Using the original DNA below to determine what type of mutation has occurred.

Normal DNA: ATCGTTAGC

- | | | |
|-------|----------------|-----------------|
| _____ | 18. AACGTTAGC | A. Substitution |
| _____ | 19. ACGTTAGC | B. Deletion |
| _____ | 20. ATTCGTTAGC | C. Insertion |

Codons Found in Messenger RNA

		Second Base				
		U	C	A	G	
First Base	U	Phe	Ser	Tyr	Cys	U
		Phe	Ser	Tyr	Cys	C
		Leu	Ser	Stop	Stop	A
		Leu	Ser	Stop	Trp	G
	C	Leu	Pro	His	Arg	U
		Leu	Pro	His	Arg	C
		Leu	Pro	Gln	Arg	A
		Leu	Pro	Gln	Arg	G
	A	Ile	Thr	Asn	Ser	U
		Ile	Thr	Asn	Ser	C
		Ile	Thr	Lys	Arg	A
		Met	Thr	Lys	Arg	G
	G	Val	Ala	Asp	Gly	U
		Val	Ala	Asp	Gly	C
		Val	Ala	Glu	Gly	A
		Val	Ala	Glu	Gly	G

21. If a mutation in the RNA base has changed the codon but the amino sequence stays the same, does it change the protein?

DNA to Protein: Protein Synthesis

Transcription: DNA contains the code necessary for a cell to produce new protein molecules during the process of protein synthesis. The sequence of DNA bases determines the type and order of amino acids found in a protein molecule. DNA is a double-stranded molecule—one strand is a coding strand and the other is a complementary strand.

22. In the spaces below, write in the bases to show the sequence that is found on the complementary strand of DNA.

Complementary DNA strand:

DNA codon	DNA codon	DNA codon	DNA codon

Coding DNA Strand

DNA codon TAC	DNA codon ATG	DNA codon CTC	DNA codon ATT
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mRNA molecules start off in the nucleus of the cell. Their function is to copy the sequence from the DNA coding strand. mRNA will differ from the DNA codons in that mRNA uses the nucleotide base uracil (U) in place of thymine (T).

23. In the spaces below, write in the mRNA codons that copy of the sequence of the DNA coding strand.

Coding DNA Strand

DNA codon TAC	DNA codon ATG	DNA codon CTC	DNA codon ATT
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mRNA Strand:

mRNA codon	mRNA codon	mRNA codon	mRNA codon

The mRNA strand leaves the nucleus, enters the cells cytoplasm, and attaches to a ribosome.

Translation: On the ribosome, the mRNA is translated by transfer RNA (tRNA) that, in turn, is used to assemble an amino acid sequence. One end of the tRNA molecule has a binding site for a specific amino acid. The other end of the tRNA molecule has the bases (anticodons) that pair with mRNA.

The mRNA genetic code chart and the mRNA genetic code wheel are tools that can be used to determine the specific amino acid that is generated from specific sequences of codons in the mRNA strand.

24. Use a mRNA genetic code chart or wheel to write the correct name of each amino acid in the blanks below.

Amino Acid Sequence:

Amino acid	Amino acid	Amino acid	Amino acid

The sequence of amino acids is known as a protein. A protein is a type of biomolecule and its monomer is _____.

25. Name 3 uses for proteins in the function of organisms.

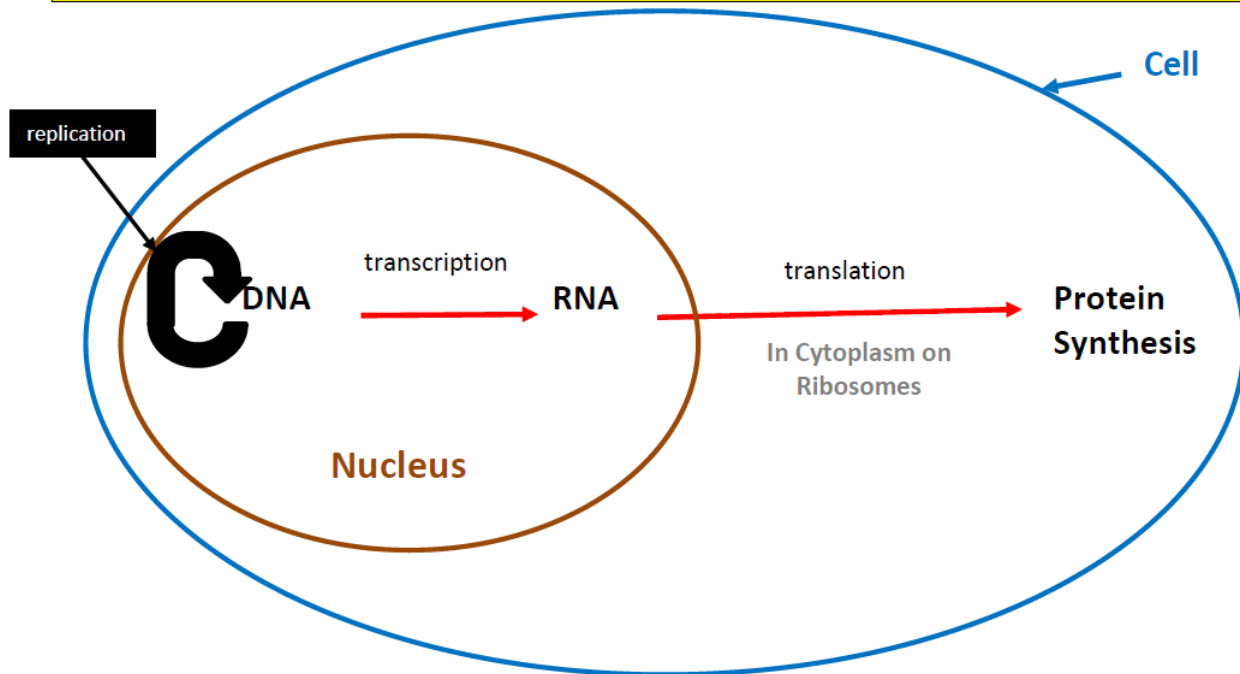
A.

B.

C.

Protein Synthesis Review:

Model of Protein Synthesis



26. Where does transcription take place? _____
27. Where does translation take place? _____ What organelle makes translation possible? _____
28. Explain the role of RNA in protein synthesis. _____
29. Let's look again at the original DNA Coding strand:

Coding DNA Strand

DNA codon	DNA codon	DNA codon	DNA codon
TAC	ATG	CTC	ATT

In the second DNA codon, if the G was changed to an A would a mutation in the amino acid sequence occur? _____

Explain your answer.

30. What is the relationship between the DNA codon and the amino acid sequence of a protein?

Part 2: Genetics & Outcomes of Various Genetic Combinations

Almost all the cells in your body were produced by mitosis. The only exceptions are the **gametes** – sperm or egg cells – which are produced by a different type of cell division called **meiosis**. During **fertilization** the sperm and egg unite to form a single cell called the **zygote** which contains all the chromosomes from both the sperm and the egg. The zygote divides into two cells by mitosis, then these cells each divide by mitosis, and mitosis is repeated many times to produce the cells in an embryo which develops into a baby.

Each cell in a normal human embryo has 23 pairs of homologous chromosomes, for a total of 46 chromosomes per cell. The sperm or egg cells (gamete) of a human each contain half of the number of chromosomes of the parent cell.

31. How many chromosomes are in a normal human zygote? ____ How many are in the normal human gamete? ____
32. The Agrodietus butterfly has 268 chromosomes in the parent cell. How many chromosomes are in the gamete? ____
33. A turkey gamete has 40 chromosomes. How many are in the turkey zygote? ____

Genetics Vocabulary: Match the definition to the correct vocabulary word

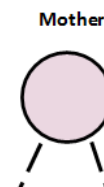
- | | |
|----------------------|--|
| 34. ____Homozygous | A. Hh |
| 35. ____Heterozygous | B. Brown eyes |
| 36. ____Phenotype | C. Genetic Makeup |
| 37. ____Genotype | D. HH or hh |
| 38. ____Karyotype | E. Has gene, may not show trait |
| 39. ____Pedigree | F. Chart of chromosome pairs |
| 40. ____Carrier | G. Maps genetic traits through generations (think family tree) |

Increasing Genetic Diversity: Monohybrid & Dihybrid Cross Activities

At your station you will find pink and blue strips of alleles (an allele is a letter representation of a specific gene). Remember that a dominant allele (capital letter) prevents a recessive allele (lowercase letter) from showing. There is also a mat with a monohybrid cross on one side and a dihybrid cross on the back. Here is the key to the alleles:

Dominant allele	A Tall body	B Brown eyes	D Dimples	E Brown hair	F No freckles
Recessive allele	a Short body	b Blue eyes	d No dimples	e Blonde hair	f freckles

- A. Select 2 pink chromosome cards (strip of alleles) from the egg container.
- B. Select 2 blue chromosome cards (strip of alleles) from the sperm container.
- C. Using the monohybrid cross side of the mat, write on the mat the 2 dimple alleles from the 2 pink cards into the mother cell. Repeat with the blue card alleles for dimples into the father cell.
- D. Bring down each allele into its respective gamete cell.
- E. Complete the monohybrid cross for each potential zygote for the dimples allele.



41. What fraction of the potential zygotes in your monohybrid cross would have dimples? ____
42. What percentage of the potential zygotes in your monohybrid cross would not have dimples? ____

Teacher Option: Repeat with another allele.

Increasing Genetic Diversity: Monohybrid & Dihybrid Cross Activities (continued)

Here is the key to the alleles:

Dominant allele	A Tall body	B Brown eyes	D Dimples	E Brown hair	F No freckles
Recessive allele	a Short body	b Blue eyes	d No dimples	e Blonde hair	f freckles

- F. Return your pink and blue cards to their respective containers. Select 2 different pink and blue cards.
- G. Using the dihybrid cross side of the mat, write on the mat the 2 alleles for freckles and eye color from the 2 pink cards into the mother cell. Repeat with the blue card and father cell.
- H. Bring down each allele into its respective gamete cell.
- I. Complete the dihybrid cross for each potential zygote for the freckles and eye color alleles.

- 43. What percentage of the offspring would be expected to be homozygous for freckles?
- 44. What percentage of the offspring would be expected to have blue eyes?
- 45. Find potential zygote box 11. What are the phenotypes expressed if this is the offspring that occurs?
- 46. Explain this statement: **Meiosis results in genetic diversity of offspring.**

Teacher option: repeat for other alleles.

47. In cocker spaniels, the allele for a black coat color (B) is dominant over the allele for a brown coat color (b). If a brown cocker spaniel is crossed with a heterozygous black cocker spaniel, which of the following genotypic ratios can be expected?

- | | | | |
|----------|------------------|----------|------------------|
| A | 0 BB: 2 Bb: 2 bb | C | 2 BB: 0 Bb: 2 bb |
| B | 1 BB: 2 Bb: 1 bb | D | 2 BB: 1 Bb: 0 bb |

- 48. Crossing-over between nonsister chromatids during meiosis is significant in heredity. This process most likely leads to an increase in which of the following?

A	The expression of dominant traits	C	The occurrence of polyploidy
B	Number of gametes	D	Genetic variation

Reflection Questions:

Consider two DNA fragments: 1- [CTG AAT GGC ATG] 2- [CTA AAG GGC ATG]

- 49. If fragment 1 is part of protein code for a chloroplast cell organelle and fragment 2 is part of the protein code for a cell with no chloroplast organelle, which Kingdom of organisms will have segment 1?
- 50. How are these fragments alike? How are they different?
- 51. What does every DNA molecule in every organism have in common?
- 52. What is it about the DNA molecule in each organism that makes the organism unique?