Unit 3: PROTEIN SYNTHESIS

Name Notes Filled In Hour

LEARNING GOALS

1. **I can name the elements found in proteins and describe the basic structure of a protein.**
   Protein Notes p.3, Comparing and Contrasting Table: Nucleic Acids v Proteins p.11, & Molecule Review p.21

2. **I can list the types of proteins and describe their functions.**
   Protein Notes p.3, Enzyme Lab (Handout), Comparing and Contrasting Table: Nucleic Acids v Proteins Table p.11, & Molecule Review p.21

3. **I can list the elements found in nucleic acids and describe the basic structure of a nucleic acid.**
   Nucleic Acid Notes p.5 & Comparing and Contrasting Table: Nucleic Acids v Proteins p.11

4. **I can list the types of nucleic acids and describe their functions.**
   Nucleic Acid Notes p.5, Building Nucleotides & DNA The Yummy Way p.9, Comparing and Contrasting Table: Nucleic Acids v Proteins p.11, & Molecule Review p.21

5. **I can compare and contrast DNA and RNA.**
   Nucleic Acid Notes p.5, Comparing and Contrasting Table: DNA v RNA p.11, & Molecule Review p.21

6. **I can describe the structures and functions of mRNA, rRNA & tRNA.**
   Nucleic Acid Notes p.5, Protein Synthesis Notes p.12, & Molecule Review p.21

7. **I can describe the process of transcription, including the functions of all of the molecules that take part in it.**
   Protein Synthesis Notes p.12, Cut & Paste Activity (Handout), & Protein Synthesis Worksheet (Handout)

8. **I can describe the process of translation, including the functions of all of the molecules that take part in it.**
   Protein Synthesis Notes p.12, Cut & Paste Activity (Handout), & Protein Synthesis Worksheet (Handout)

9. **I can explain what a mutation is, describe the different types and their possible outcomes.**
   Mutation Notes p.17 & Mutation Activity p.18

VOCABULARY

- Adenine
- Amino acid
- Anticodon
- Base-Pairing Rule
- Chromosomal mutation
- Codon
- Cytosine
- Deoxyribonucleic acid
- Double helix
- Enzyme
- Frameshift mutation
- Gene
- Gene mutation
- Guanine
- Messenger RNA
- Mutation
- Nitrogenous base
- Nuclear pore
- Nucleotide
- Nucleus
- Peptide bond
- Polypeptide chain
- Point mutation
- Protein
- Ribonucleic acid
- Ribosome
- RNA polymerase
- Thymine
- Transcription
- Transfer RNA
- Translation
- Uracil

Warm-Ups

Remember to copy down the warm-up question from the board. Answer the warm-up using your knowledge and notes. When we review the question as a class it is your responsibility to correct your answer. If you are absent, it is your responsibility to get the warm-up and correct answer from a classmate.

9-26-14
9-29-14
9-30-14
10-1-14

10-2-14

10-3-14

10-6-14

10-7-14

10-8-14

Protein Notes

LG 1 - I can name the elements found in proteins and describe the basic structure of a protein.
LG 2 - I can list the types of proteins and describe their functions.

- Monomer: amino acid

  20 different amino acids

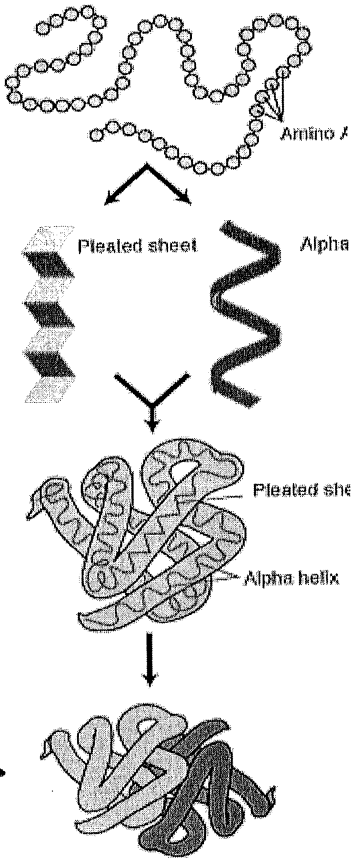
  Example – Tryptophan

- Polymer: polypeptide chain

  Reason for Name: Peptide bonds hold amino acids together

  Smallest chain – 45 amino acids

  Largest chain – 34,000 amino acids



- Structure:
  - Chains of amino acids fold to form a 3-D shape.
  - Looks like a blob

- Elements:

C - carbon, O - oxygen, H - hydrogen, + N - nitrogen

- Overall Function:

  Part of all living processes

Broken into 8 different types/functions in the body:

1. Type: Contractile + Motor

   Function: Movement

   Examples:
   - Actin and myosin are responsible for the movement of muscles.
   - Other proteins are responsible for the undulations of the organelles called cilia & flagella

2. Type: Hormonal

   Function: Coordination of organisms activity

   Examples:
   - Insulin, a hormone secreted by the pancreas, helps regulate the concentration of sugar in the blood of vertebrates

3. Type: Enzymes

Function: Accelerate chemical reactions (speeds them up!)

Examples: Digestive enzymes catalyze (speed up) the process of breaking down food:

- Amylase – breakdown of starches to sugars
- Lipase – digestions of lipids
- Protease – digestion of proteins (yes, digestion of proteins by proteins)
- Cellulase – breakdown of cellulose (found in herbivorous animals)

They all end in -ase

4. Type: Structural

Function: Support

Examples:

- Insects and spiders use silk fibers to make their cocoons & webs
- Collagen & elastin provide a fibrous framework animal connective tissue
- Keratin is the protein of hair, horns, features, and other skin appendages

5. Type: Storage

Function: Storage of Amino Acids

Examples:

- Ovalbumin is the protein of egg white, used as an amino acid source for the developing embryo
- Casein, the protein of milk, is the major source of amino acids for baby mammals.
- Plants have storage proteins in their seeds

6. Type: Transport

Function: Transport of other substances

Examples:

- Hemoglobin, the iron-containing protein of vertebrate blood, transports oxygen from the lungs to other parts of the body
- Other proteins transport molecules across cell membranes

7. Type: Receptor

Function: Response of cell to chemical stimuli

Examples:

- Proteins built into the membrane of a nerve cell detect chemical signals released by other nerve cells

8. Type: Defensive

Function: Protect against disease

Examples:

- Antibodies (proteins) combat bacteria and viruses.

In short – what do proteins DO? EVERYTHING!

Enzyme Lab

INTRODUCTION

In order to obtain energy and other essentials, our bodies must break down the food polymers that we consume, such as carbohydrates, proteins and lipids. Specific enzymes catalyze all of these reactions. Liver and other tissues contain the enzyme catalase. This enzyme breaks down hydrogen peroxide (H_2O_2This necessary because our cells create hydrogen peroxide during a sub-process of cellular respiration. Hydrogen peroxide is poisonous to our cells, so it must be immediately broken down. Our cells are constantly making poisonous chemicals, but they don't die because a variety of different enzymes break down the poisonous chemicals into harmless substances. The reaction you will be seeing today does just that. Write the chemical equation below:

What are the two products of this reaction? _____ and _____

Are either of these two chemicals harmful to your body? _____

PURPOSE

To determine...

- What does catalase do?
- Are enzymes reusable, or do they get used up during a chemical reaction?
- Which tissues contain catalase?

MATERIALS

- Test tubes
- Forceps
- Scissors
- Hydrogen peroxide (H_2O_2)
- 10mL graduated cylinder
- Liver - raw and cooked
- Chicken
- Apple
- Potato

PROCEDURE

Throughout this investigation you will estimate the rate of the reaction (how rapidly the solution bubbles) on a scale of zero to five. (0=no reaction, 1=slow, ... 5=very fast) For part 1 of the procedure, assume that the reaction you will observe is at a rate of "4".

Part 1: What does catalase do?

1. Place 2 mL of hydrogen peroxide solution into a clean test tube.
2. Using forceps and scissors, cut a small piece of liver and add it to the test tube. Push it into the hydrogen peroxide with a stirring rod. Observe and record the rate of reaction in your data table. (Remember, we're calling this one a "4".)

a. What gas is being released? (ANSWER QUESTIONS IN DATA TABLE)

b. Recall that a reaction that absorbs heat is endothermic and a reaction that gives off heat is exothermic. Feel the test tube with your hand. Based on your observation, is this reaction endothermic or exothermic?

c. Now that the reaction is complete (meaning it's done bubbling), what is the liquid in your test tube?

Part 2: Is catalase reusable?

1. Pour off the liquid from part 1 into a clean test tube.

d. What do you think would happen if you added more liver to this liquid?

2. Add a new piece of liver to the test tube and record the reaction rate in your data table.

e. Explain your results (why did that happen?).

3. Add another 2mL of hydrogen peroxide to the liver remaining in the first test tube and record the reaction rate in the data table.

f. Is catalase reusable?

Part 3: Which tissues contain catalase?

1. Place 2mL of hydrogen peroxide in each of four clean test tubes.
2. Add a small piece of potato to the first test tube and record the reaction rate in the data table. Add a small piece of chicken to the second test tube and record the reaction rate. Add a small piece of apple to the third test tube and record the reaction rate. Add a small piece of cooked liver to the fourth test tube and record the reaction rate.

g. Which tissues contain catalase?
h. Do some contain more catalase than others?
i. How can you tell?
j. Does the cooked liver perform the same way as the raw liver? Give a possible reason for this.

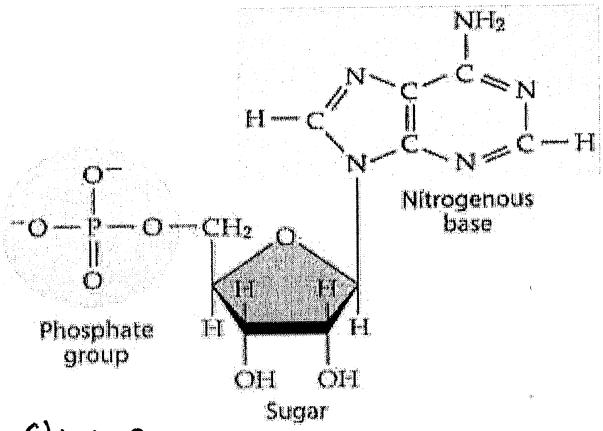
DATA TABLE

		Reaction Rate (0-5)	Observations and Questions
Part 1	Normal Liver		a. b. c.
Part 2	Liver added to Used H_2O_2		d. e.
	Reused Liver		f.
Part 3	Potato		g.
	Chicken		h.
	Apple		i.
	Cooked Liver		j.

Nucleic Acid Notes (DNA & RNA)

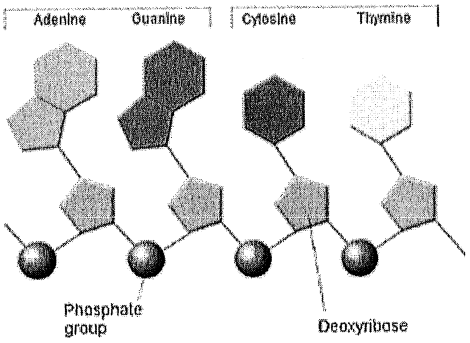
LG 3 - I can list the elements found in nucleic acids and describe the basic structure of a nucleic acid.
LG 4 - I can list the types of nucleic acids and describe their functions.
LG 5 - I can compare and contrast DNA and RNA.
LG 6 - I can describe the structures and functions of mRNA, rRNA & tRNA.

The Parts of a Nucleic Acid

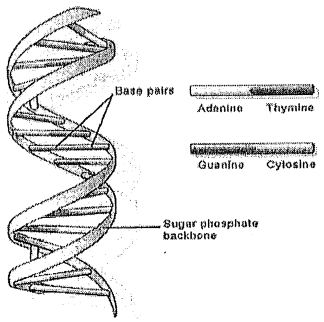


- Polymer: Nucleic Acid
- Monomer: Nucleotide
  - Sugar
  - Phosphate Group
  - Nitrogen Base
- Elements: C- Carbon, H - Hydrogen, O - Oxygen N - Nitrogen, P- Phosphorous
- Types:
  - DNA - Deoxyribonucleic Acid
  - RNA – Ribonucleic Acid

About DNA



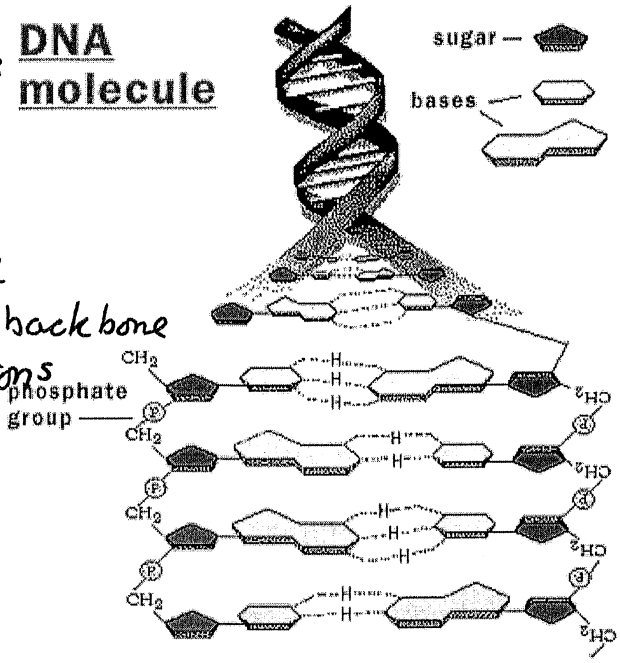
- Sugar type: Deoxyribose
- Four nitrogen bases types:
  - Adenine (A)
  - Guanine (G)
  - Cytosine (C)
  - Thymine (T)



- Base-pairing Rule:
  - A pairs with T
  - G pairs with C
  - Given the following strand of DNA, write the complementary strand of **DNA** below it:

    C G C T T A C C A G A T
    G C G A A T G G T C T A

- Structure: Two chains of nucleotides attached to create a "twisted ladder" - Double Helix



  - Ladder sides:
    - Made of sugar & phosphate
    - Called the sugar-phosphate backbone
    - 2 sides run in opposite directions
  - Ladder steps:

    Two nitrogen bases bonded together by hydrogen bonds.

- Function:

  DNA codes for proteins.

About RNA

- Sugar type: ribose

- Four nitrogen bases types:
  - Adenine (A)
  - Guanine (G)
  - Cytosine (C)
  - Urasil (U)

- Base-pairing Rule:
  - A pairs with U A - U
  - C pairs with G C - G
  - Given the following strand of DNA, write the complementary strand of **RNA** below it:

    C G C T T A C C A G A T

    G C G A A U G G U C U A

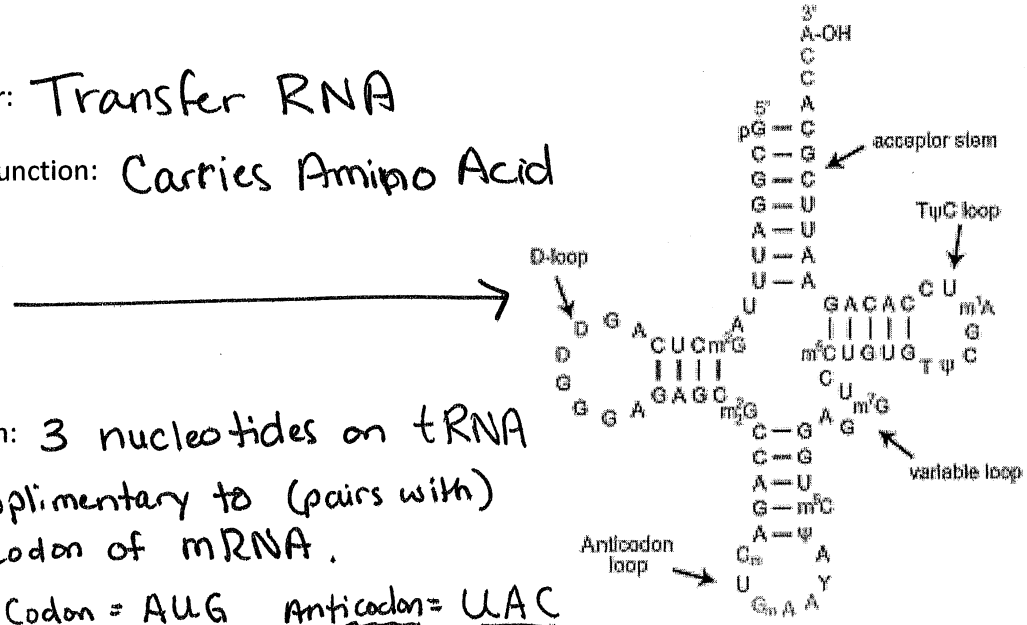
- Structure: One chain of nucleotides

- Function: Help build proteins using DNA's code

- About Each Type of RNA:

1. mRNA:
   - Stands for: Messenger RNA
   - Specific Function: Carries DNA code out of the nucleus
   - Image: 

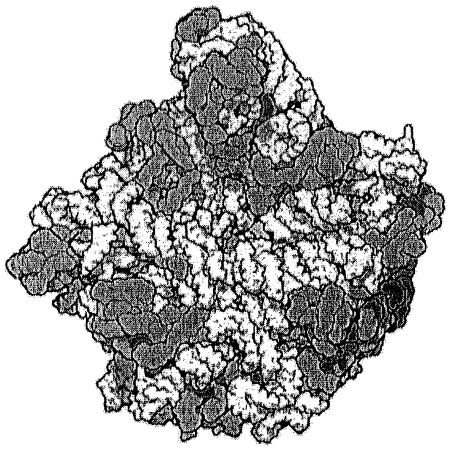
   - Codon: 3 nucleotides on mRNA (always starts with AUG)

2. tRNA:
   - Stands for: Transfer RNA
   - Specific Function: Carries Amino Acid
   - Image: 

   - Anticodon: 3 nucleotides on tRNA
     - complimentary to (pairs with) a codon of mRNA.
     - Ex Codon = AUG Anticodon = UAC

3. rRNA:
   - Stands for: Ribosomal RNA
   - Specific Function:

     Part of a ribosome (cell part) which reads mRNA + assembles amino acids into a polypeptide chain.
   - Image of a Ribosome:
     - Beige: rRNA
     - Blue: Protein (blob!)
     - Green: Active site

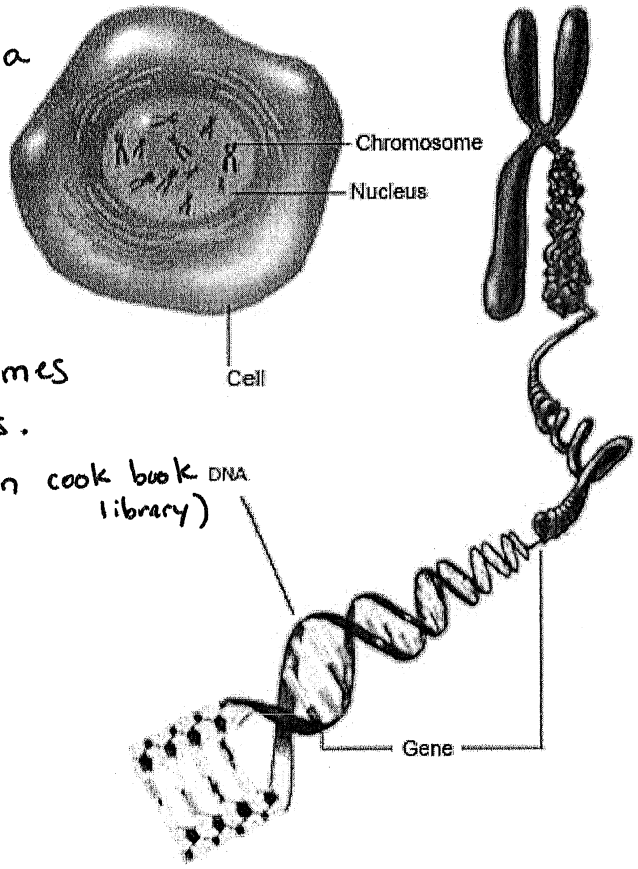


The Discovery of DNA's Structure

- In the early 1950's a British scientist named Rosalind Franklin began to study DNA.
- She used X-ray diffraction to get information about the structure of the DNA molecule.
- Francis Clark and James Watson used Franklin's images to discover the shape of DNA: A double helix.
- They built 3-D models from information Franklin discovered about the shape of DNA.

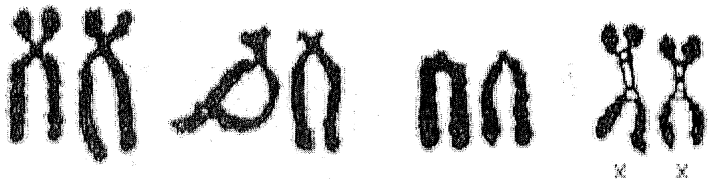
DNA Vocabulary

- Gene: Section of DNA that codes for a protein. (protein recipe)
- Chromosome: Piece of DNA containing many genes (protein cook book)
- Genome: Collection of all chromosomes in an organism or species. (protein cook book DNA library)



Primitive v Advanced Organisms

- In primitive organisms (bacteria):
  - No nucleus
  - Most have one single circular DNA molecule (one chromosome in its genome)
- In advanced organisms (plants, animals, & fungus):
  - Many have more than 1000 times the amount of DNA as bacteria.
  - Located in a nucleus.
  - Genome contains multiple chromosomes, depends on organism:
    - Humans: 46
    - Fruit flies: 8
    - Sequoia trees: 22



Building Nucleotides & DNA the Yummy Way!

LG 4 - I can list the types of nucleic acids and describe their functions.

Review:

1. What is the monomer of a nucleic acid? _____
2. What are the three parts of the monomer? _____

   _____
3. What are the four nitrogenous bases found in DNA and their abbreviations?

   _____

   _____
4. What does the rule of base-pairing state? _____
5. DNA's shape is known as the _____ _____ (twisted ladder).
6. What are the sides of the ladder called for DNA? _____
7. What are the rungs of the ladder made up of? _____
8. How are the two sides of the ladder held together? _____

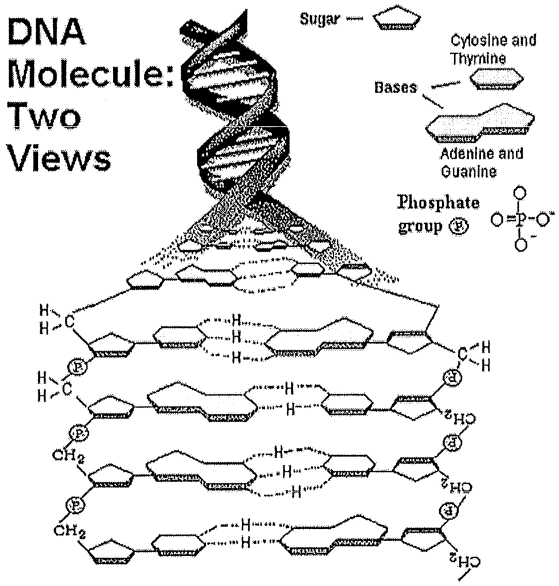
Now its time to build:

1. Wash your hands and your workstation. Lay down some paper towel to build your models on.
2. Gather your materials: 4 marshmallows of each color, 16 red licorice pieces, and 16 black licorice pieces. (Toothpicks are at your table)
3. Assign roles:
   - Red licorice: _____
   - Black licorice: _____
   - Pink marshmallow: _____
   - Yellow marshmallow: _____
   - Orange marshmallow: _____
   - Green marshmallow: _____
   - Toothpicks: _____
4. Assemble all 16 nucleotides:
   - For each bond only use a half of a toothpick.
   - Be sure that your phosphate group is coming out of the top of your sugar and the nitrogenous base is coming out the side of your sugar.

5. Create a DNA strand that is 8 nucleotides long and reads: AAGTCGCT
   - Note: make sure the sugar-phosphate backbone is intact so you can pick up the strand
6. Create a complementary strand of DNA using the rule of base pairing.
   - Write down the bases in your complementary strand:_____
   - As we discussed in the notes, the sugar-phosphate backbone should go in opposite directions.
7. Make sure that your DNA model is bonded together completely, then pick up the model and give it the correct shape. What did you do to your model to give it the correct shape? _____
8. Call your teacher over to check your model.

Analysis

1. What part of your model represented the sugar-phosphate backbone?
2. What part of your model represented the nitrogen bases?
3. What part of your model represented bonds between the molecules?
4. What type of bonds would be found between the nitrogen bases of DNA?
5. Describe how your model represented rule of base pairing.
6. If this were a model of an RNA molecule, how would it be different? (List 3 things)



Clean-up

You may eat your model! **(Remember to remove the toothpicks first ☺)**

Return your cup of toothpicks to the supply table. Throw away all other uneaten materials and your paper towels in the trash.

Comparing and Contrasting Tables

LG 1 - I can name the elements found in proteins and describe the basic structure of a protein.
LG 2 - I can list the main types of proteins and describe their functions.
LG 3 - I can list the elements found in nucleic acids and describe the basic structure of a nucleic acid.
LG 4 - I can list the types of nucleic acids and describe their functions.

Nucleic Acids v Proteins		
Polymer	Nucleic Acid	Protein
Monomer		
Elements		
Structure		
Overall Function		
Types		

LG 5 - I can compare and contrast DNA and RNA.

DNA v RNA			
	Only DNA	**Both/Have in Common**	**Only RNA**
Naming			
Monomer Parts			
Rule of Base-Pairing			
Structure			
Function			

Protein Synthesis Notes

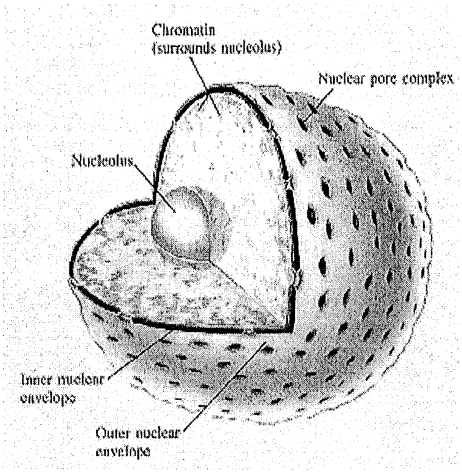
LG 6 - I can describe the structures and functions of mRNA, rRNA & tRNA.
LG 7 - I can describe the process of transcription, including the functions of all of the molecules that take part in it.
LG 8 - I can describe the process of translation, including the functions of all of the molecules that take part in it.

Protein synthesis is made up of two main processes and involves a number of cell parts and a number of different molecules.

Sub-Process #1: TRANSCRIPTION

Reason for Name: Transcribing DNA code into RNA

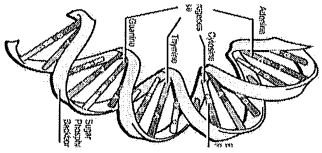
Location/Cell Parts:



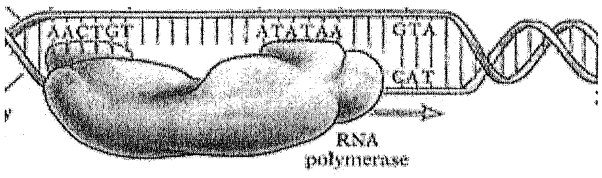
- Nucleus – location of DNA
- Nuclear pore – hole in the membrane of the nucleus

Molecules Needed:

- DNA – holds the code for every protein made by the body.



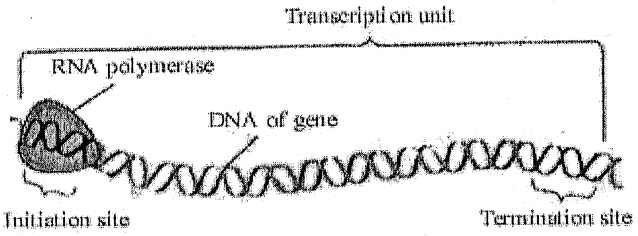
- RNA polymerase – an enzyme that makes mRNA during transcription.



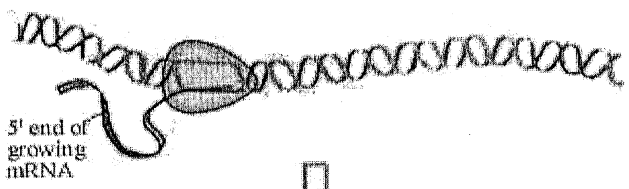
- mRNA – acts as a message from DNA.

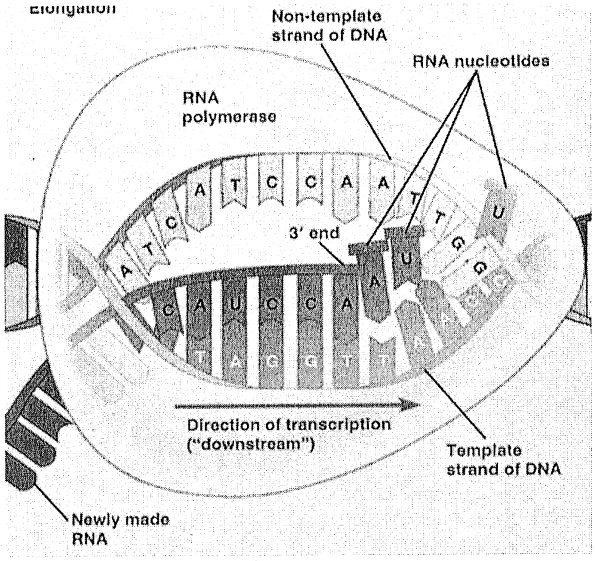
Steps of Transcription:

1. In the nucleus, RNA polymerase attaches to DNA & unzips it at the beginning of a gene.

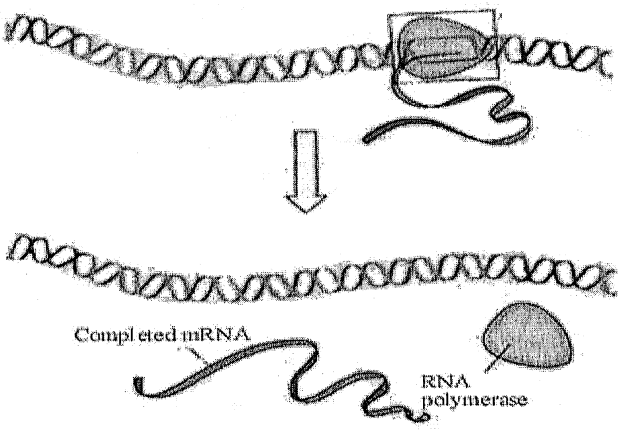


2. RNA polymerase uses one side of the DNA strand as a template to make a complementary mRNA molecule.

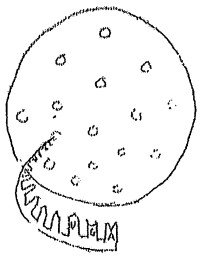




3. At the end of the gene's code, RNA polymerase detaches from DNA and mRNA is released.



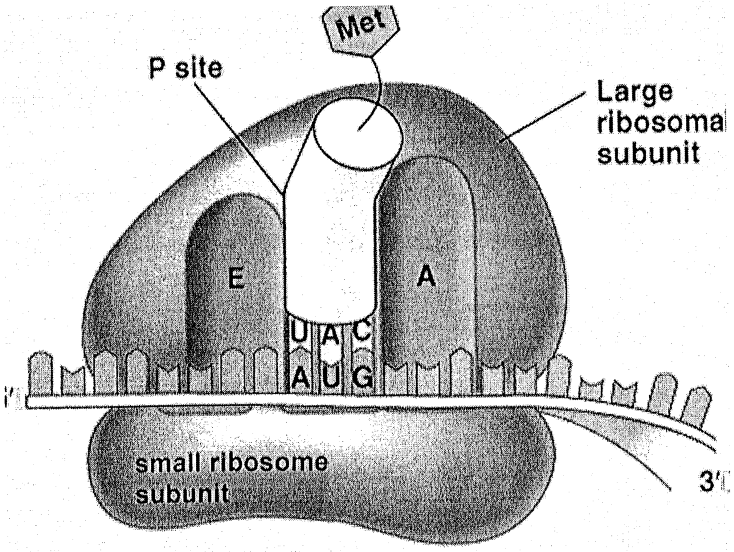
4. mRNA leaves the nucleus through a nuclear pore.



Transcription Animation Links:

- **Animation #1:** http://www-class.unl.edu/biochem/gp2/m_biology/animation/gene/gene_a2.html
- **Animation #2:** http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/transcription.swf

Sub-Process #2: TRANSLATION

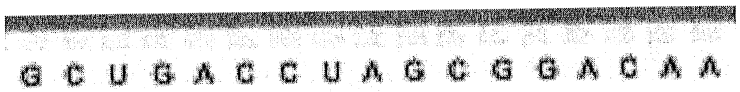


Location/Cell Parts:

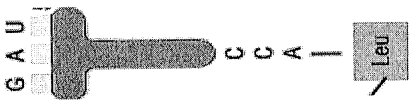
- Cytoplasm – fluid in the cell.
- Ribosome – Part of the cell containing rRNA and where amino acids are assembled into a polypeptide chain.

Molecules Needed:

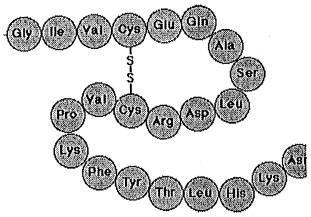
- mRNA – Carries the DNA message out of the nucleus to a ribosome.



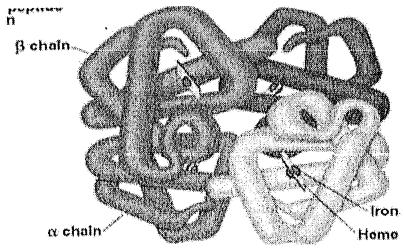
- tRNA – Responsible for transferring the correct amino acid to the ribosome.



- Amino acids – The monomer (building block) of a protein.
- Polypeptide chain – A long chain of amino acids held together by peptide bonds.



- Protein – One or more polypeptide chains folded into a specific 3-D shape.



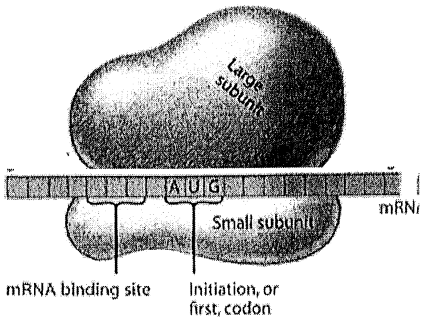
(b) Hemoglobin

Vocabulary:

- Codon – 3 nucleotides on an mRNA molecule.
- Start codon – translation begins at this codon, AUG.
- Stop codon – one of three codons that signal translation to stop: UAA, UAG & UGA.
- Anticodon – 3 nucleotides on a tRNA molecule (complementary to a codon on mRNA)

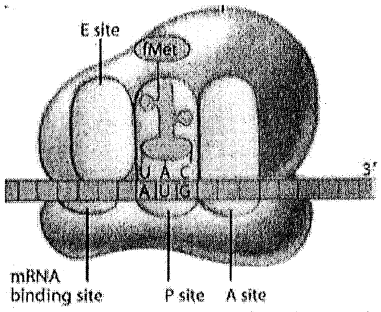
Steps of Translation:

1. mRNA travels through the cytoplasm and attaches to a ribosome.

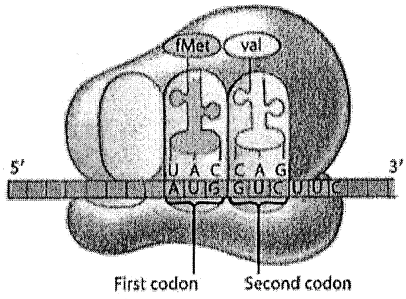


2. The start codon (AUG) on mRNA passes through the ribosome.

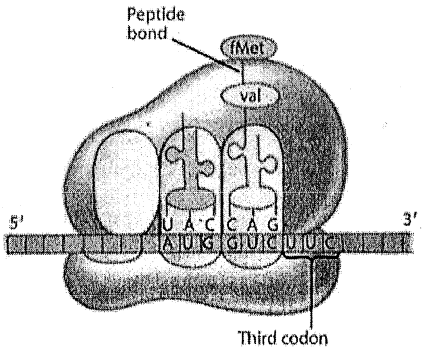
3. A tRNA with the complementary anticodon (UAC) enters the ribosome and attaches to the start codon. This tRNA molecule has brought with it the amino acid methionine (see codon chart on the next page).



4. The ribosome shifts down to the next codon and a complementary tRNA attaches and brings with it the next amino acid.

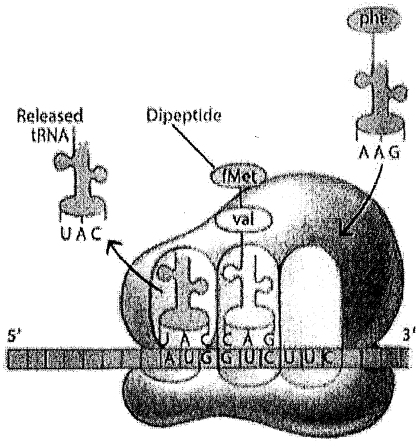


5. The two amino acids are linked together by the ribosome with a peptide bond.

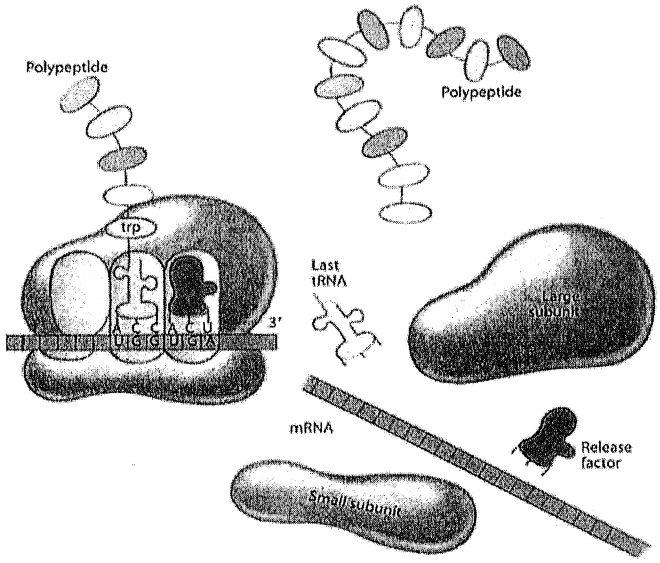


6. The first tRNA molecule detaches from its amino acid and is released from the ribosome to find a free methionine amino acid and wait until it's needed again.

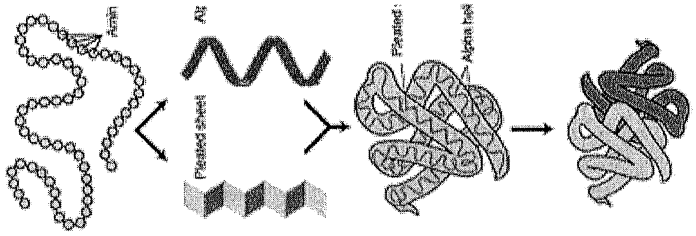
7. The ribosome shifts down again to "read" the next codon and steps 5 – 7 are repeated.



8. The polypeptide chain grows until a stop codon passes though the ribosome and all molecules are released (mRNA, tRNAs, & polypeptide chain).



9. The polypeptide chain is folded into its correct 3D shape and is now considered a protein.



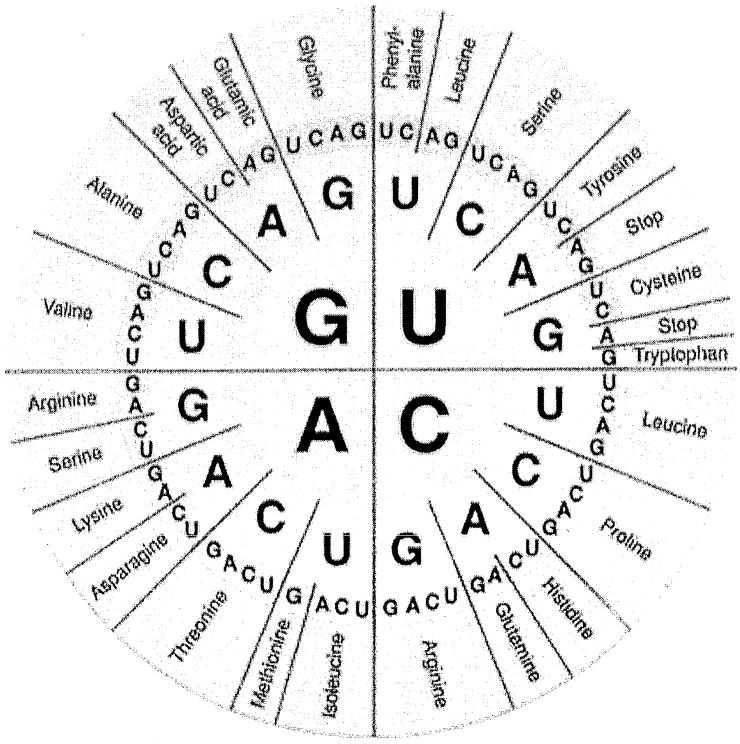
Translation Animation Links:

- **Animation #1:** http://www-class.unl.edu/biochem/gp2/m_biology/animation/gene/gene_a3.html
- **Animation #2:** http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/translation.swf

Codon Chart

Shows how the 20 amino acids are coded for by the 64 different codons.

To use, start in the middle with the first letter of the codon and move outwards.



Practice:

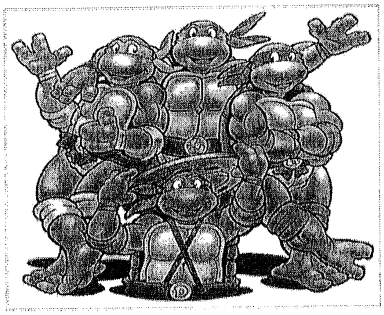
- Codon: GCA → Amino acid: Alanine
- Codon: UCA → Amino acid: Serine
- What amino acid does the start codon code for?
- What are the three stop codons?

UAA, UAG, UGA

Mutations Notes

LG 9 - I can explain what a mutation is, describe the different types and their possible outcomes.

What is a mutation? A change or mistake in DNA



What causes a mutation to happen?

- Sometimes cells make mistakes when copying their DNA.
- Radiation (like sunlight, microwaves, atomic bomb) and chemicals (carcinogens, nuclear waste, "green ooze") can cause these mutations to happen more frequently.

The two main types of mutations are:

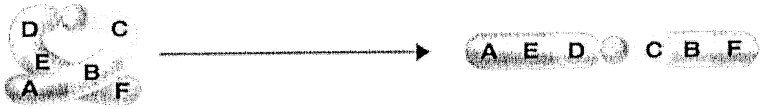
1. **GENE mutations (2 types):**
   a. Point Mutation - in which a single nucleotide is affected. This type of mutation usually changes one amino acid in a protein.
   b. Frame-Shift Mutation - in which the "reading frame" is shifted. The genetic code is read in groups of 3 bases. So, inserting or deleting a nucleotide changes the reading frame and affects every single amino acid that follows the mutation.

2. **CHROMOSOMAL mutations (4 types):**
   a. Deletion - a whole section of a chromosome is missing, meaning there is no information for one or several genes.

   b. Duplication - a section of the chromosome has one or more extra copies.

   c. Translocation - parts of two different chromosomes are traded.

   d. Inversion - when the genes on a single chromosome flip spots and are then in reverse order.



Mutations Activity

LG 9 - I can explain what a mutation is, describe the different types and their possible outcomes.

Point Mutations

1. Here is the original strand of DNA: TAC GCA TGG AAT ...etc.
2. Transcribe this DNA message into mRNA: _____ _____ _____ _____ ...etc.
3. Translate this mRNA message into a polypeptide:

   _____ _____ _____ _____...etc.

4. The same strand of DNA, but with a **substitution** (bolded): TAC G**T**A TGG AAT ...etc.
5. Transcribe this DNA message into mRNA: _____ _____ _____ _____...etc.
6. Translate this mRNA message into a polypeptide:

   _____ _____ _____ _____...etc.

7. Compare the two polypeptides created in steps 3 & 6:

   _____

8. The same strand of DNA, but with a **different substitution** (bolded): TAC GC**G** TGG AAT ...etc.
9. Transcribe this DNA message into mRNA: _____ _____ _____ _____ ...etc.
10. Translate this mRNA message into a polypeptide:

    _____ _____ _____ _____...etc.

11. Compare the polypeptide you created in step 10 to the original polypeptide created in step 3:

    _____

12. Does ***every*** point mutation (or substitution) cause a change in the polypeptide created? _____
13. Why or why not?_____

    _____

Frameshift Mutation

14. Here is the original strand of DNA: TAC GCA TGG AAG ...etc.

15. Transcribe this DNA message into mRNA: _____ _____ _____ _____ ...etc.

16. Translate this mRNA message into a polypeptide:

_____ _____ _____ _____...etc.

17. The same strand of DNA, but with a **deletion:** TAC GCA GGA AGA ...etc.

18. Which nucleotide was deleted (compare to #14)? _____

19. Where did the last "A" come from? _____

20. Transcribe this DNA message into mRNA: _____ _____ _____ _____ ...etc.

21. Translate this mRNA message into a polypeptide:

_____ _____ _____ _____...etc.

22. Compare the two polypeptides created in steps 16 & 21:

_____

_____

23. The same strand of DNA, but with an **insertion**: TAC GGC ATG GAA ...etc.

24. Which nucleotide was inserted (compare to #14)? _____

25. Where did the last "T" go? _____

26. Transcribe this DNA message into mRNA: _____ _____ _____ _____ ...etc.

27. Translate this mRNA message into a polypeptide:

_____ _____ _____ _____...etc.

28. Compare the polypeptide you created in step 27 to the original polypeptide created in step 16:

_____

_____

29. Does ***every*** frameshift mutation (deletion or insertion) cause a change in the polypeptide created?____

30. How much of the protein is effected? _____

_____

_____

Chromosomal Mutations

31. Cri-du-chat (cat cry) syndrome: Affected children have a cat-like high-pitched cry during infancy, mental retardation and physical abnormalities. This syndrome occurs when part of chromosome 5 is missing.

    This is an example of a chromosomal _____.

32. Mantle Cell Lymphoma, a type of cancer that is not considered curable, is caused by parts of chromosome 11 and chromosome 14 trading places.

    This is an example of a chromosomal _____.

33. Sometimes the X chromosome can break in two places and come back together in reverse order. This can cause mild mental retardation, short stature and cleft palate.

    This is an example of a chromosomal _____.

34. In Antarctic Ice fish there was a mutation that caused created two copies of the gene for protease. One of the copies mutated which resulted in a protein that acts like antifreeze. This was beneficial to the species.

    This is an example of a chromosomal _____.

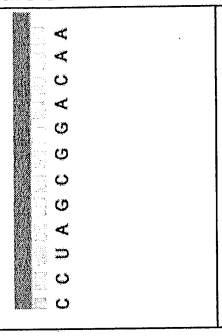
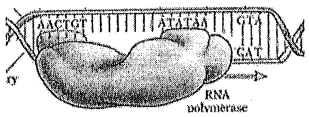
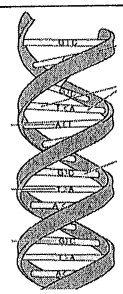
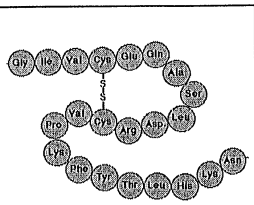
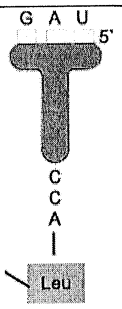
Molecule Review

LG 1 - I can name the elements found in proteins and describe the basic structure of a protein.
LG 2 - I can list the main types of proteins and describe their functions.
LG 4 - I can list the types of nucleic acids and describe their functions.
LG 5 - I can compare and contrast DNA and RNA.
LG 6 - I can describe the structures and functions of mRNA, rRNA & tRNA.

Color each box below to correspond with the molecule(s) that match the description or picture. If two molecules match the picture or description then color the box ½ one color and ½ the other color.

DNA = Red mRNA = Orange tRNA = Yellow Protein = Green RNA Polymerase = Blue

Picture of Molecule

Monomer of molecule

Nucleotides made out of deoxyribose, a phosphate group and one of the following nitrogeneous bases: A, T, C, G	Amino acids	Nucleotides made out of ribose, a phosphate group and one of the following nitrogeneous bases: A, U, C, G

Shape of molecule

Picket fence	Twisted ladder	A specific 3D shape.	Usually looks T shaped with 3 bases sticking down and an amino acid attached to the top.

Location of molecule in the cell

Found only in the nucleus.	Made in nucleus but travels out a nuclear pore, through cytoplasm to the ribosome.	Everywhere inside and outside of the cell.	Found in the cytoplasm.

Function of molecule

Brings amino acids to the ribosome during translation.	Holds the code for all proteins in an organism.	Structure, transport, regulates chemical reactions, storage, sends messages, receptors, movement, defense.	Carries a copy of DNA's code out to the ribosome.	Unzips DNA and polymerizes RNA nucleotides to produce an mRNA strand during transcription.

Miscellaneous

3 bases on this molecule are called a codon.	3 bases on this molecule are called an anticodon.	The two sides of this molecule are held together by hydrogen bonds.	The parts of this molecule are held together by peptide bonds.	This molecule is an enzyme.

Base Pairing Rules:

DNA:	**RNA:**