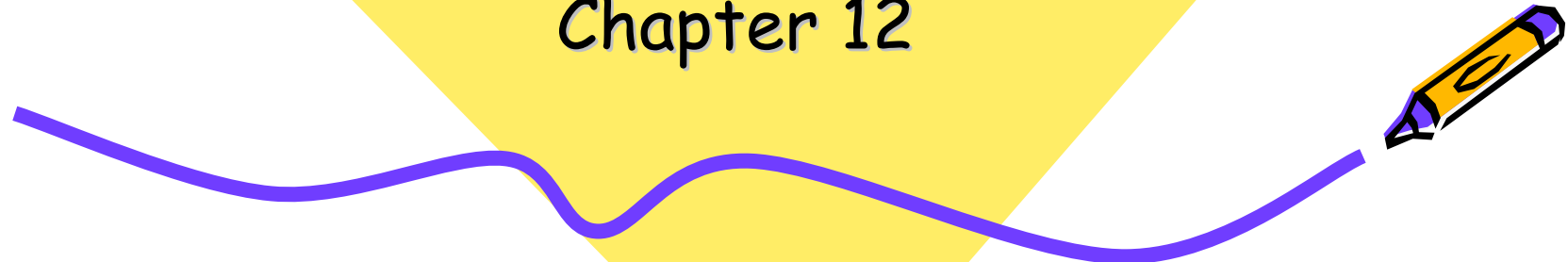




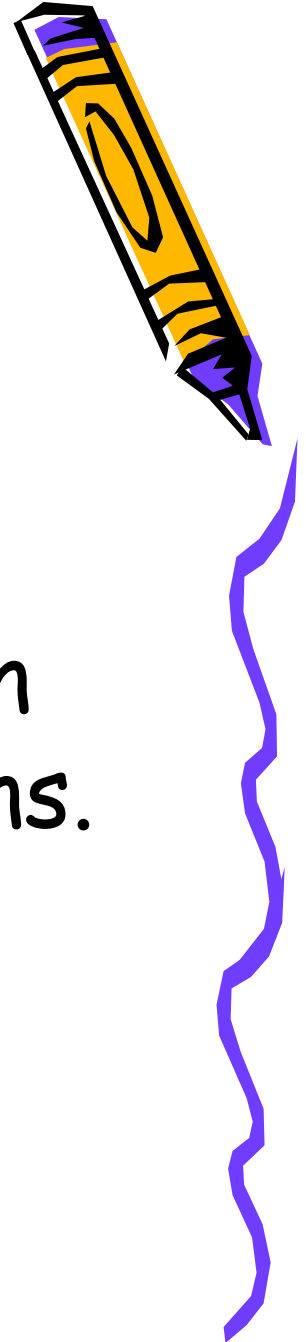
DNA,  
Transcription,  
Translation

Chapter 12

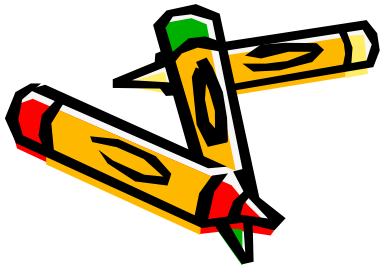
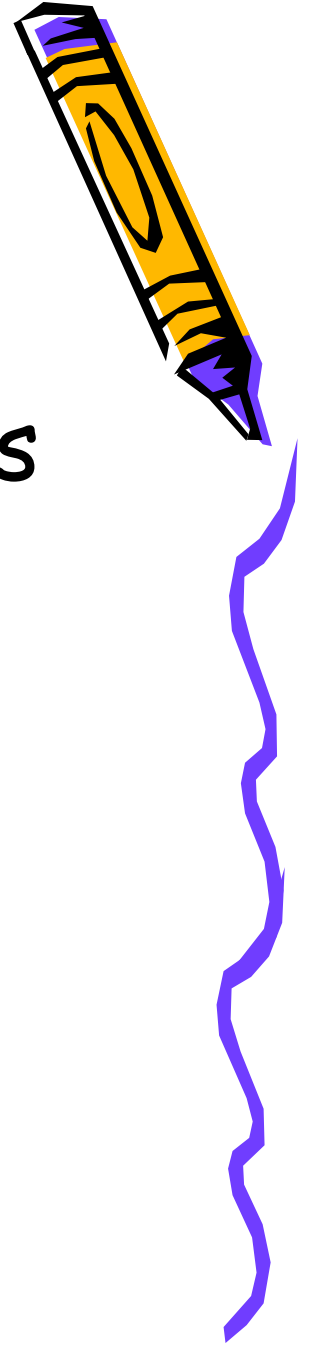


# DNA

- DNA = Deoxyribonucleic acid
- Found in the nucleus of a cell
- Called the "blueprint of life" because it contains information for the construction of proteins.

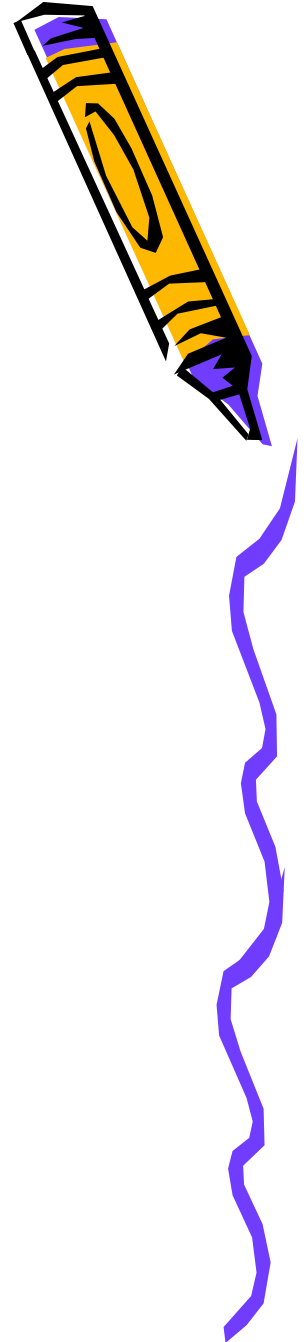


- DNA is made of two long chains of nucleotides

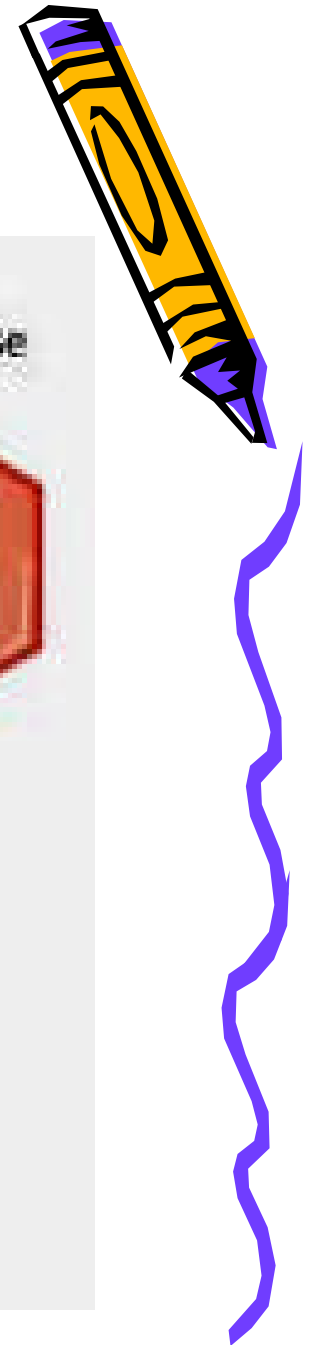
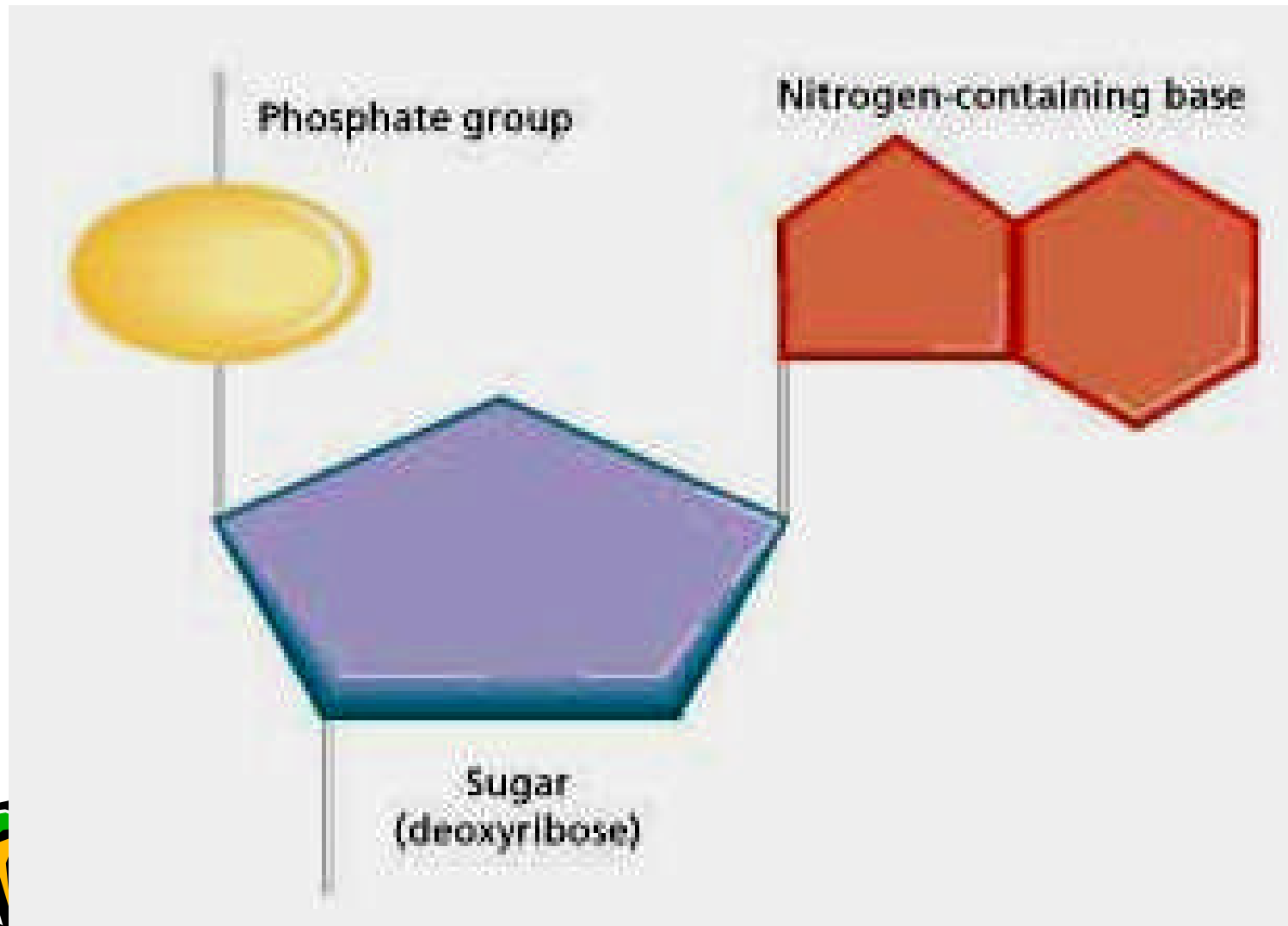


# What's a nucleotide?

- Nucleotide:
  - Sugar: deoxyribose
  - Phosphate group
  - Nitrogenous base



# Nucleotide



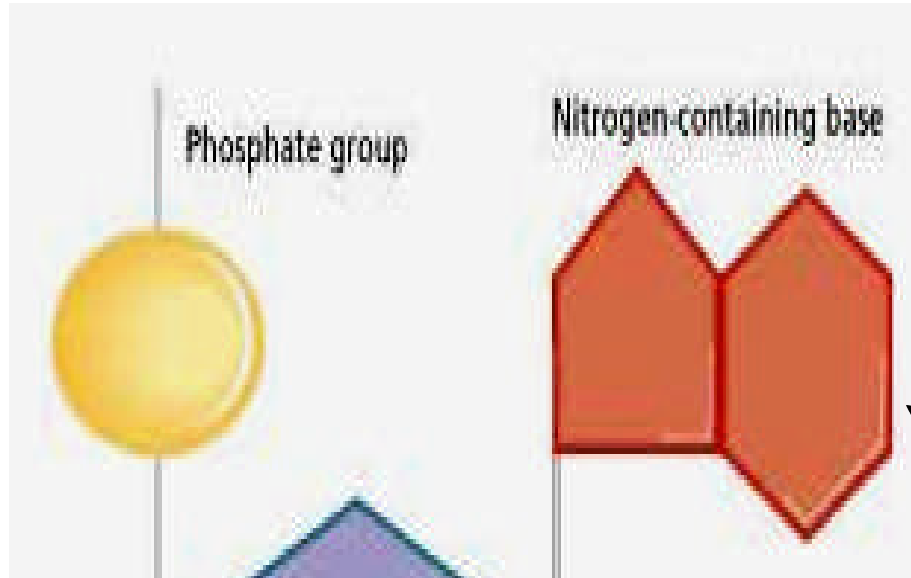
# Nitrogenous Bases

There are two groups of nitrogenous bases:

- Purines: bases that have two rings of carbon and nitrogen
  - Adenine (A), Guanine (G)
- Pyrimidines: bases that have one ring of carbon and nitrogen
  - Thymine (T), Cytosine (C),  
Uracil (U)

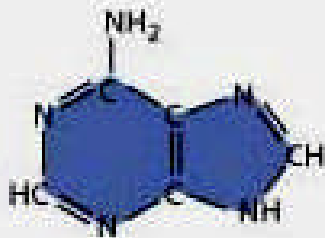


# Purines and Pyrimidines

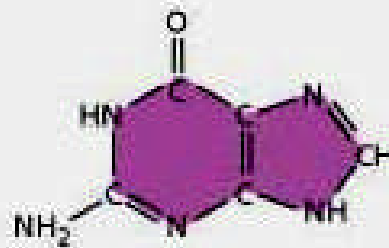


## PURINES

Adenine

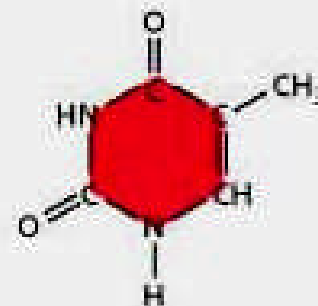


Guanine

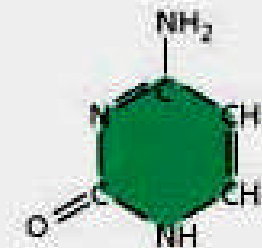


## PYRIMIDINES

Thymine

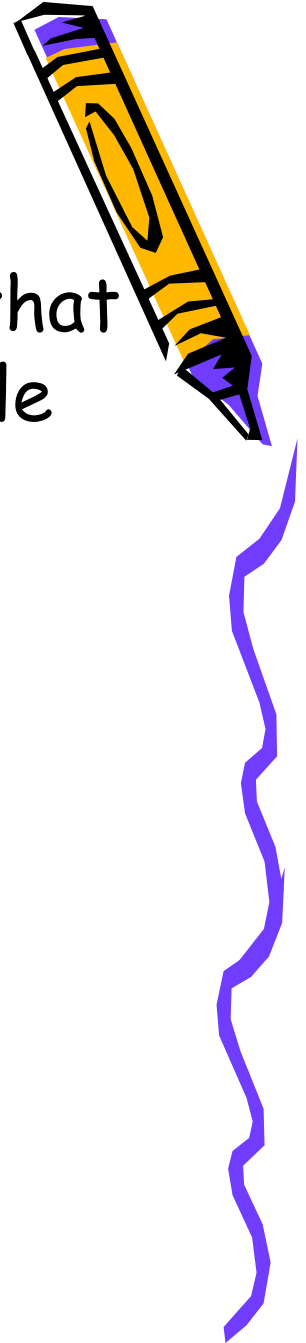


Cytosine

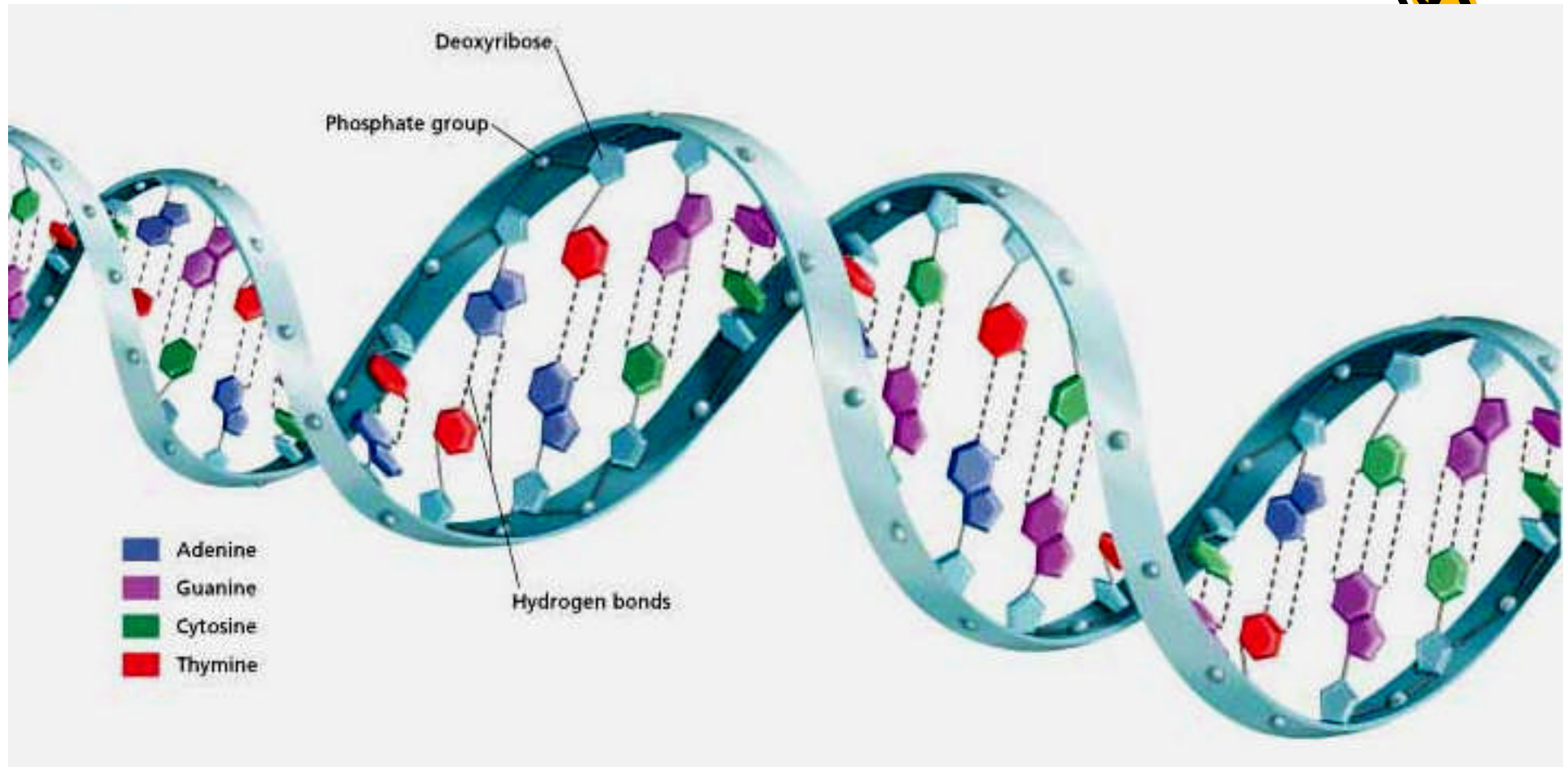
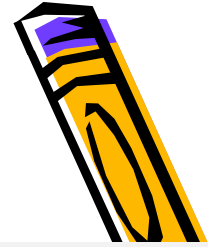


# DNA Structure

- DNA is made of two nucleotide chains that wrap around each other to form a double helix
  - Looks like a spiral staircase
- The nitrogenous bases link together to connect the two strands
  - A pairs with T
  - G pairs with C

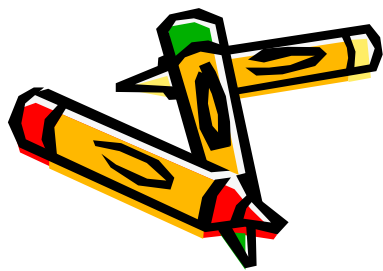
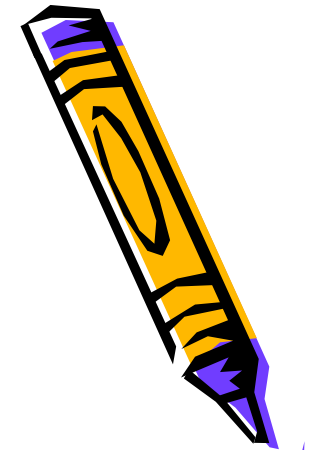
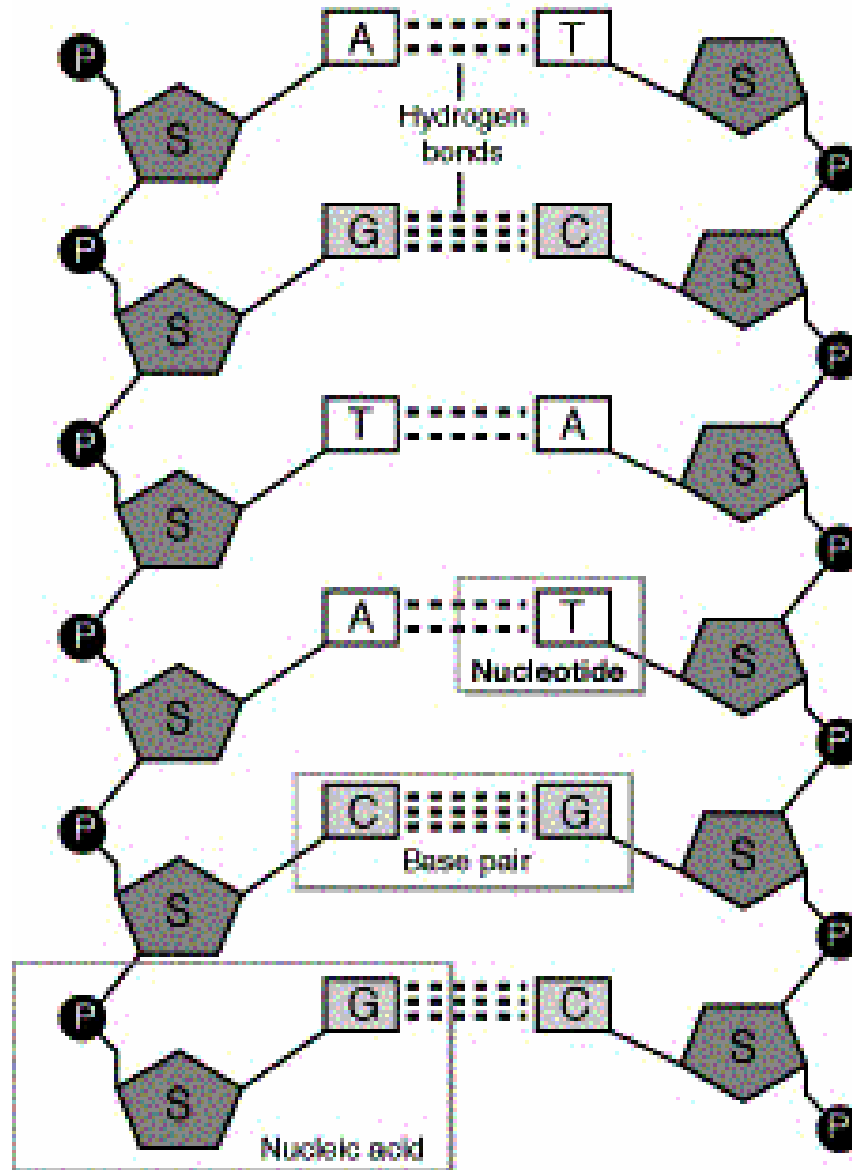


# Double Helix



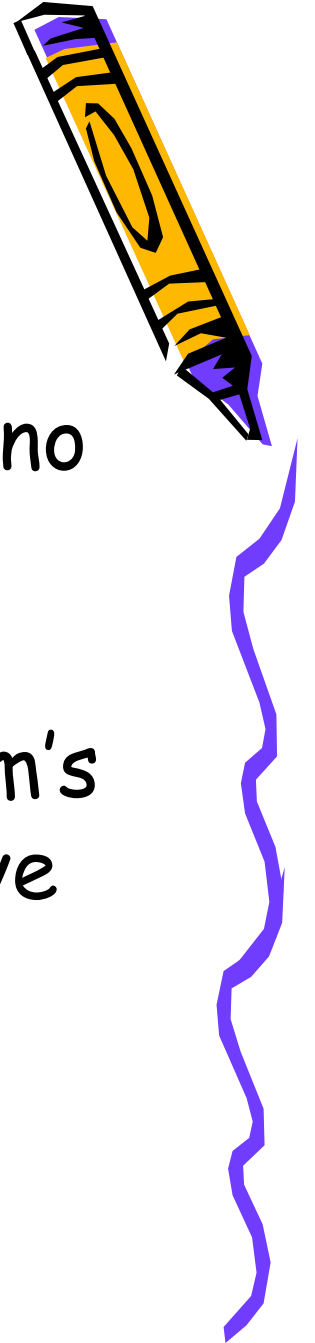
# Deoxyribonucleic Acid (DNA)

Sugar-phosphate backbone		Nucleotide base pairs		Sugar-phosphate backbone
--------------------------	--	-----------------------	--	--------------------------



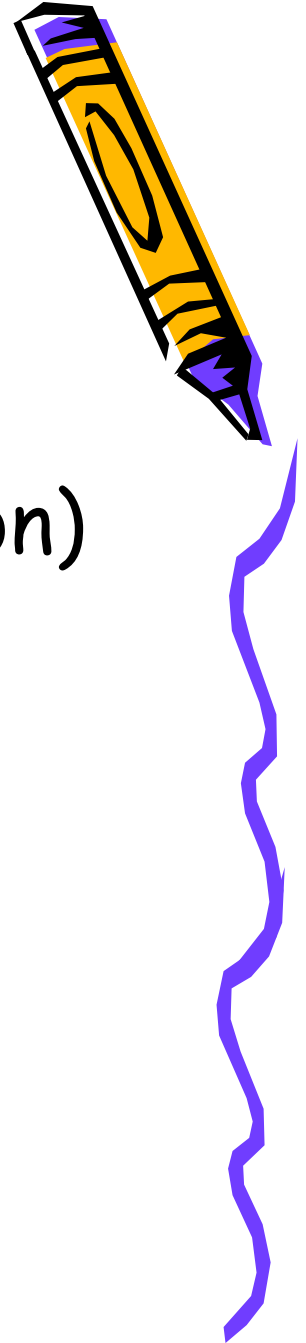
# What is a protein?

- Protein: a polypeptide chain of amino acids
- Proteins carry out the genetic instructions encoded in an organism's DNA so the DNA never has to leave the nucleus



# How does DNA make a Protein?

- Protein synthesis is a two step process (Transcription , Translation)
- The instructions for building a protein are in the nucleus
- The tools needed to build the proteins are in the cytosol.
- Problem?



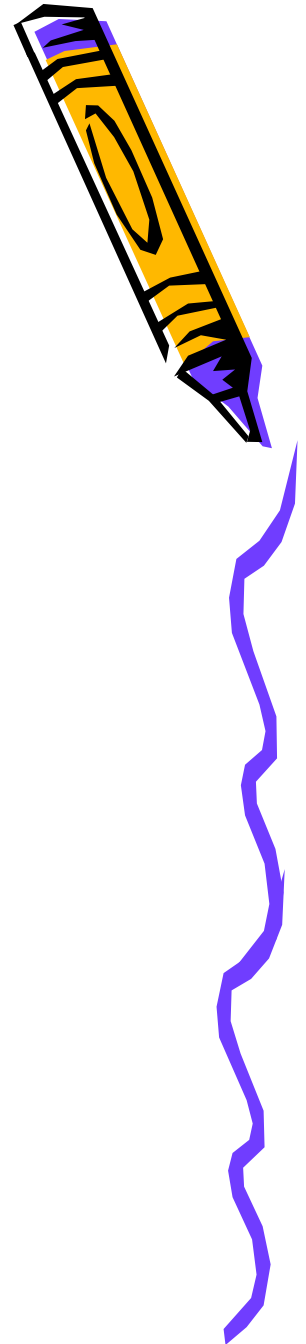
# Solution

- The instructions for protein synthesis that are encoded in the DNA are transported into the cytosol via RNA
- There is a special type of RNA that will carry the instructions into the cytosol, and special types that will build the protein



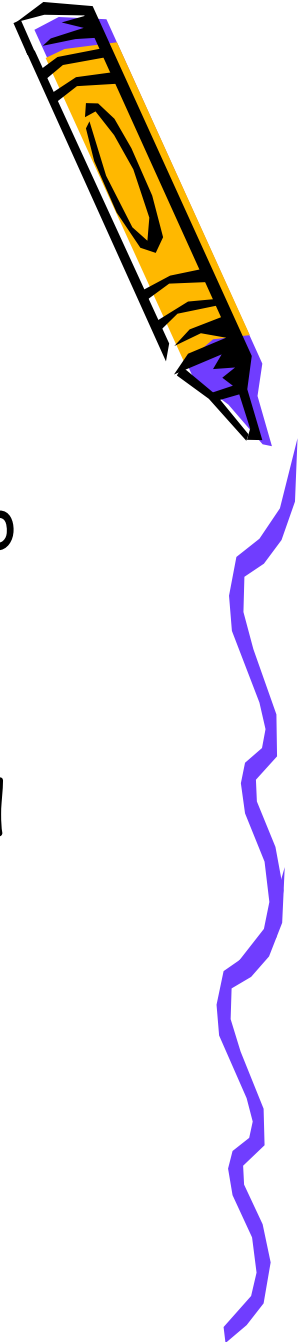
# RNA

- RNA: Ribonucleic Acid
- Looks just like DNA with 3 differences
  - Has a ribose sugar instead of deoxyribose
  - Is composed of one strand of nucleotides instead of two
  - Has a Uracil base instead of a Thymine
    - The U pairs with A



# 3 types of RNA

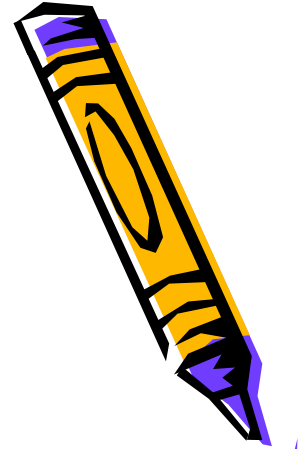
- Messenger RNA (mRNA): carries the genetic information from the nucleus to the cytosol
- Transfer RNA (tRNA): hairpin shape RNA that binds to a specific amino acid
- Ribosomal RNA (rRNA): makes up the ribosomes where proteins are made



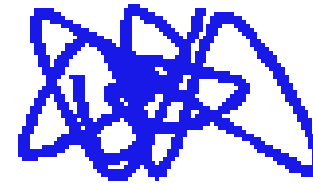
# Self Check

- What information does DNA contain?
- Name the three components of a nucleotide
- What sugar is found in DNA
- How do the purines and pyrimidines pair up?
- Why does DNA need to be converted into RNA?

What shape is DNA?

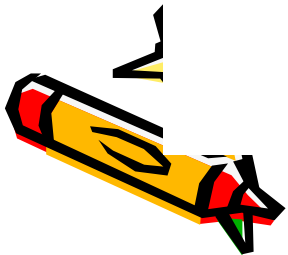


DNA → mRNA → protein



transcription

translation

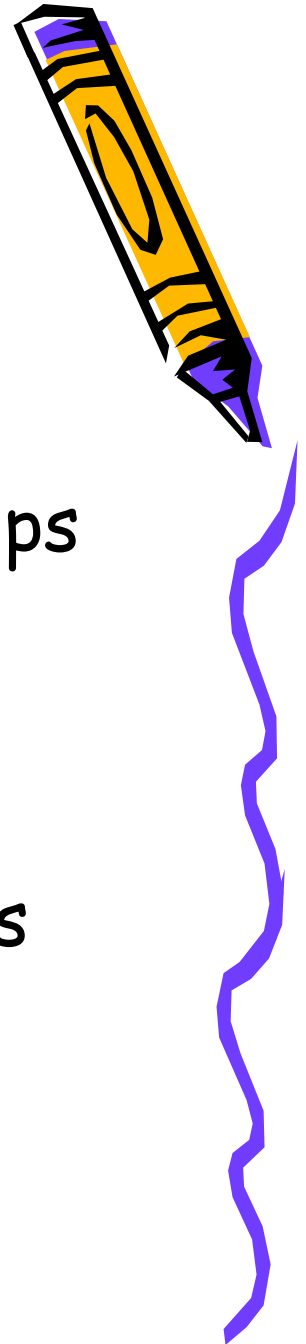


# Transcription

- Transcription: the process of converting DNA into mRNA
- Takes place in the nucleus
- **STEP 1**: RNA polymerase binds to a region of DNA called the Promoter
- **STEP 2**: RNA polymerase adds bases that pair with the DNA, substituting Uracil for Thymine



- **STEP 3:** RNA polymerase reaches a termination signal and transcription stops
- **STEP 4:** The new mRNA strand is released from the DNA template
- **STEP 5:** mRNA leaves the nucleus and enters the cytosol for protein synthesis



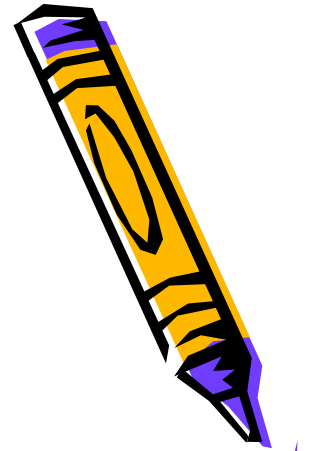
# Transcription

...T A C C G G A C C T G A A G T... DNA

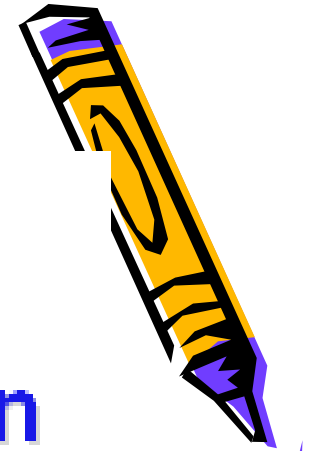
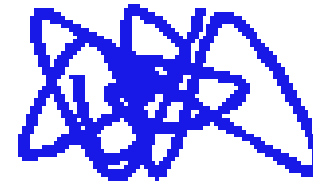


Transcription

...A U G G C C U G G A C U U C A... mRNA

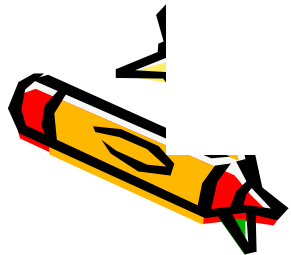


DNA → mRNA → protein



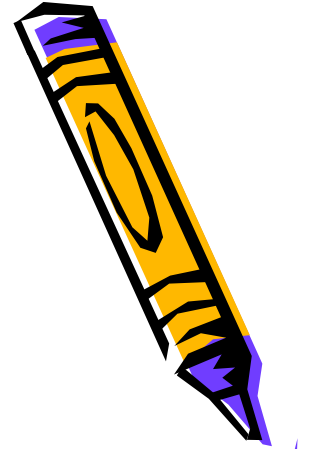
transcription

translation



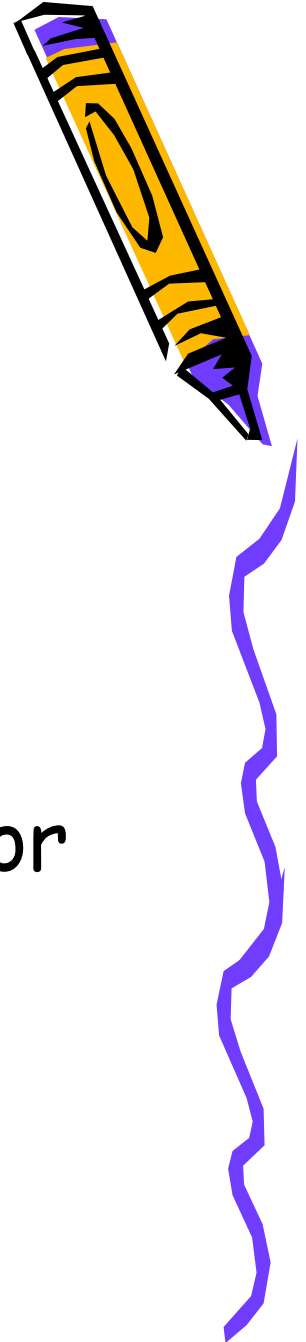
# Translation

- Translation: The process of converting mRNA into proteins
- Takes place in the cytosol on top of a ribosome
- Cytosol contains amino acids, tRNA, and ribosomes, which are needed for protein synthesis



# Codons

- Codon: a combination of 3 mRNA nucleotides
- Every codon codes for a specific amino acid
- There are also codons that code for the "start" and "stop" of transcription



# Codon Table



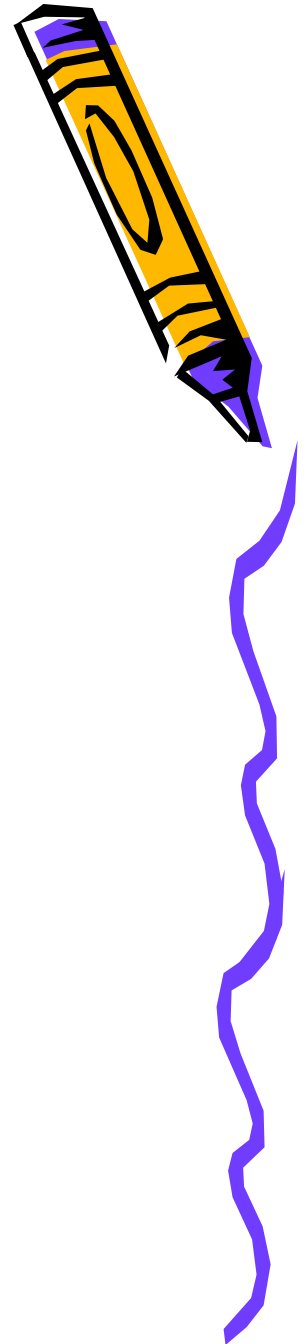
**TABLE 10-1 Codons in mRNA**

First base	Second base				Third base
	U	C	A	G	
U	UUU } Phenylalanine	UCU	UAU } Tyrosine	UGU } Cysteine	U
	UUC } Phenylalanine	UCC } Serine	UAC } Tyrosine	UGC } Cysteine	C
	UUA } Leucine	UCA	UAA } Stop	UGA } Stop	A
	UUG } Leucine	UCG	UAG } Stop	UGG } Tryptophan	G
C	CUU	CCU	CAU } Histidine	CGU	U
	CUC } Leucine	CCC } Proline	CAC } Histidine	CGC } Arginine	C
	CUA	CCA	CAA } Glutamine	CGA	A
	CUG	CCG	CAG } Glutamine	CGG	G
A	AUU } Isoleucine	ACU	AAU } Asparagine	AGU } Serine	U
	AUC } Isoleucine	ACC } Threonine	AAC } Asparagine	AGC } Serine	C
	AUA } Isoleucine	ACA	AAA } Lysine	AGA } Arginine	A
	AUG } Start	ACG	AAG } Lysine	AGG } Arginine	G
G	GUU	GCU	GAU } Aspartic acid	GGU	U
	GUC } Valine	GCC } Alanine	GAC } Aspartic acid	GGC } Glycine	C
	GUA	GCA	GAA } Glutamic acid	GGA	A
	GUG	GCG	GAG } Glutamic acid	GGG	G



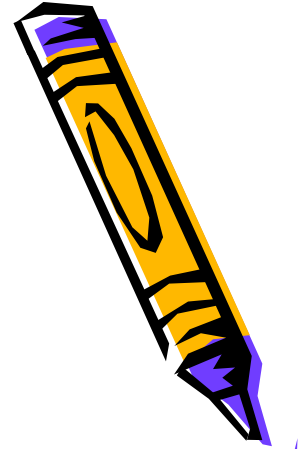
# Translation

- **Step 1:** The start codon (AUG) is recognized by the tRNA
- **Step 2:** the tRNA binds to the mRNA and brings an amino acid (methionine) with it



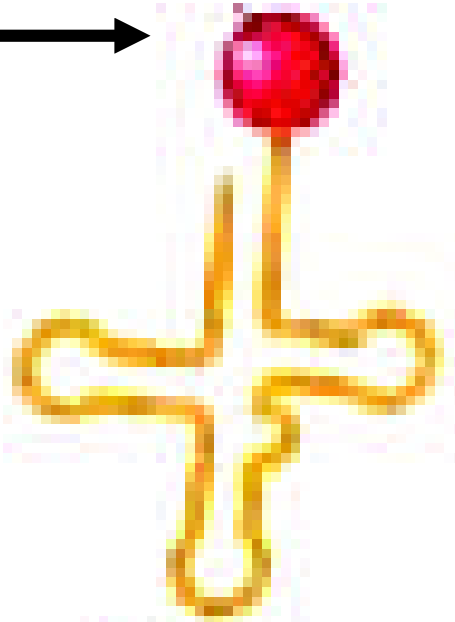
# tRNA

- tRNA is essential to translation
- Each tRNA molecule carries an amino acid to the ribosome
- tRNA recognizes and binds to the mRNA molecule by an anti-codon
- Anti-codon: a region of tRNA consisting of three bases complementary to the mRNA codon

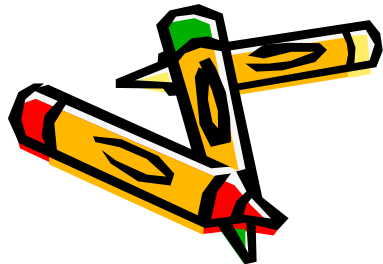
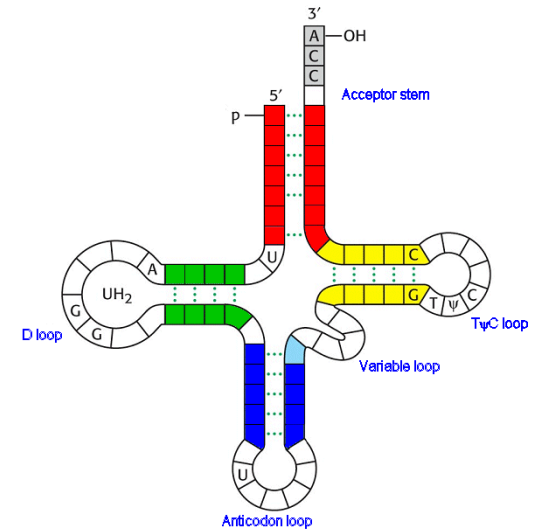


# tRNA picture

Amino Acid

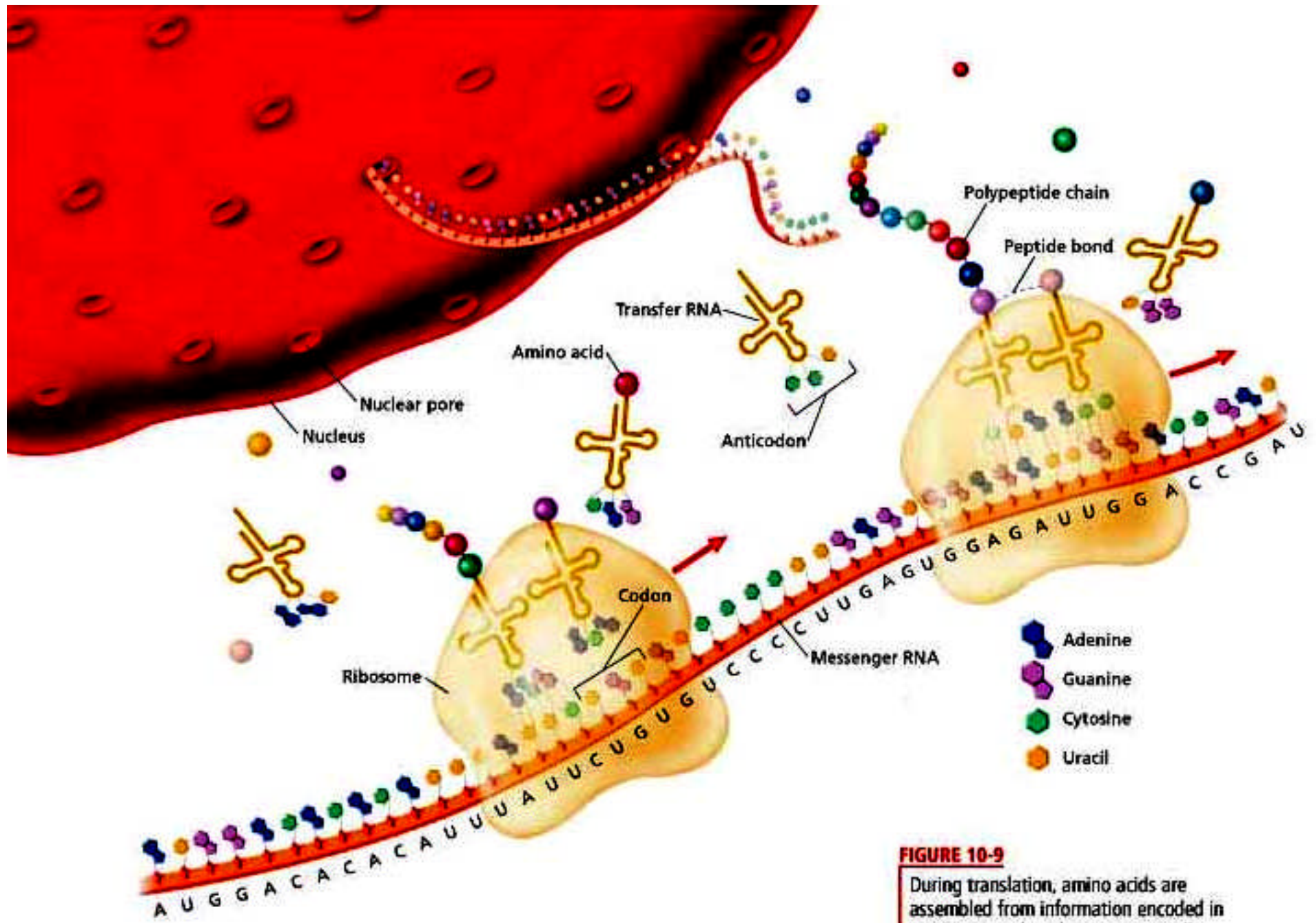


Anti-codon



- **Step 3:** The tRNA specific for the next codon binds to the mRNA and the amino acid it brings binds to the first amino acid
- **Step 4:** This process continues building a chain of amino acids until a stop codon is reached
- **Stop Codons:** UAA, UAG, UGA





**FIGURE 10-9**

During translation, amino acids are assembled from information encoded in mRNA.

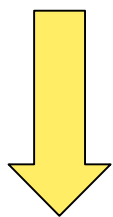




DNA

TAC CGA TCT TTC  
ATG GCT AGA AAG

← Read from here.



Transcription

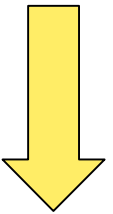
mRNA

AUG GCU AGA AAG

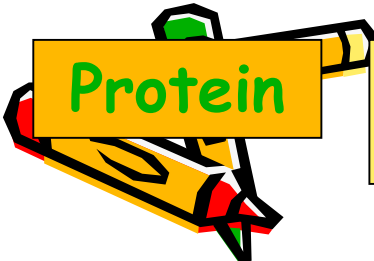
Nucleus  
Cytoplasm/  
Cytosol

mRNA

AUG GCU AGA AAG



Translation



Protein

Methionine (M)

Alanine (A)

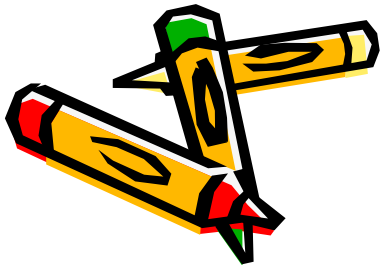
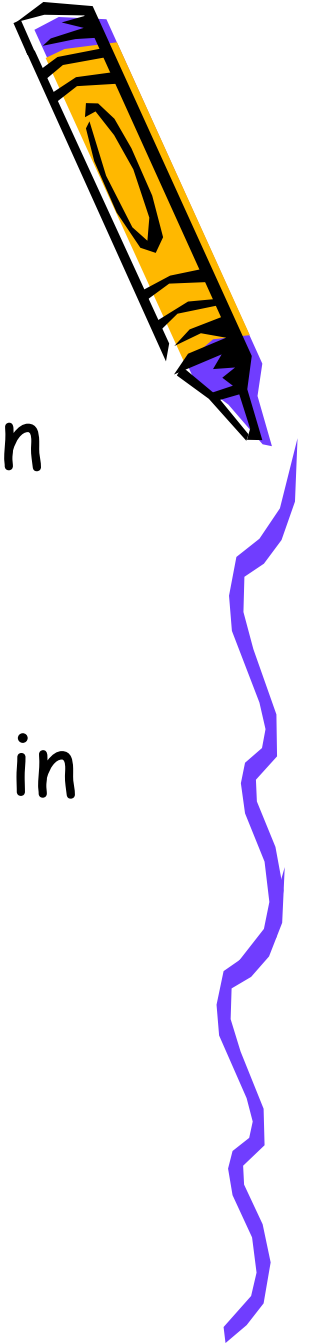
Arginine (R)

Lysine (K)

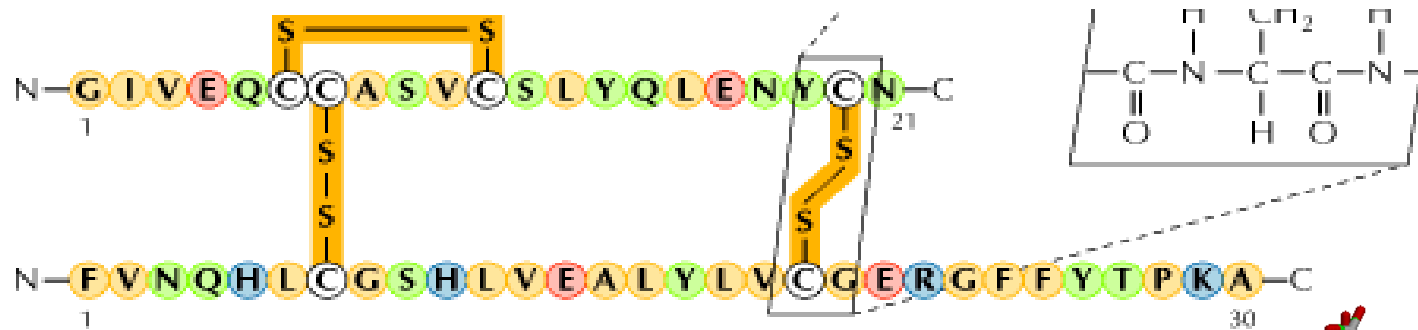


# Proteins

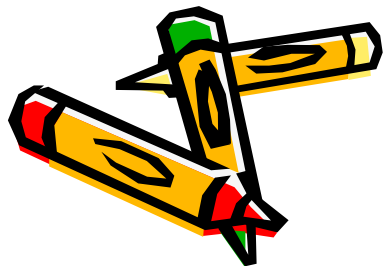
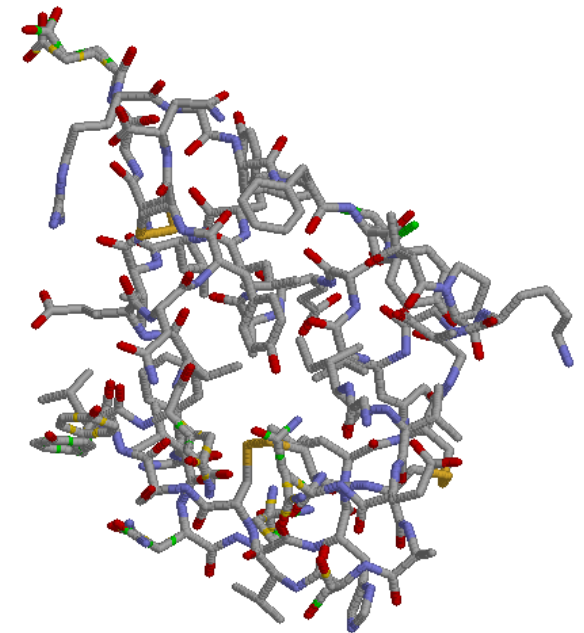
- Proteins differ from one another in the number and sequence of amino acids
- They can be 50-3,000 amino acids in length



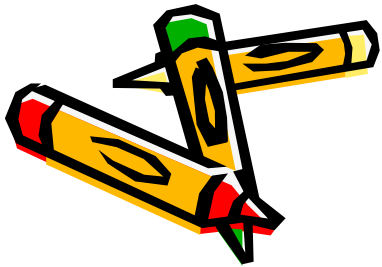
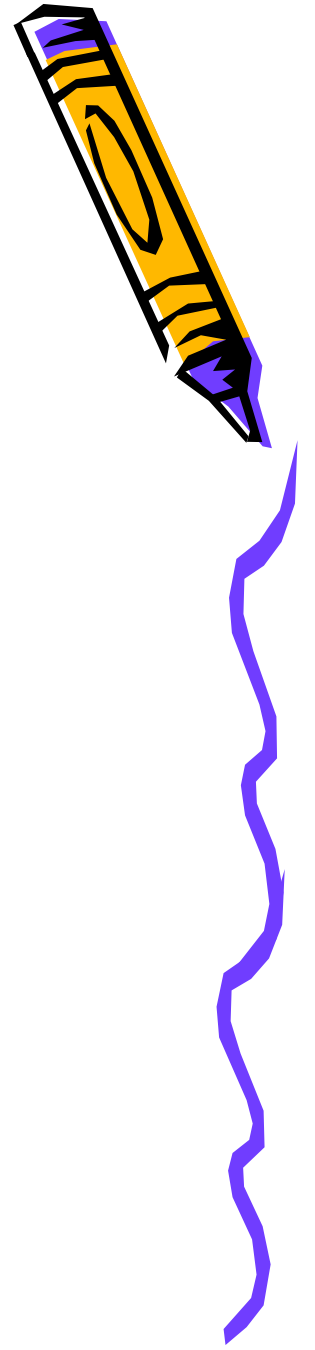
The completed chain of amino acids form a protein



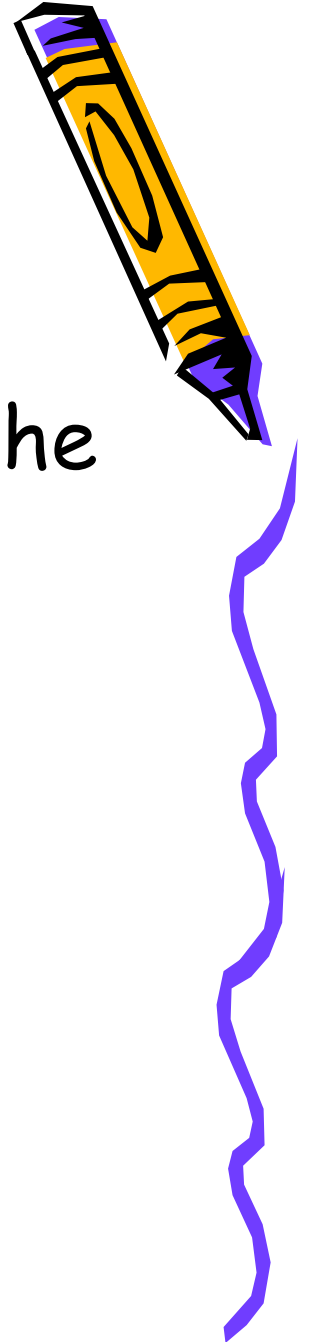
Insulin



When things go wrong

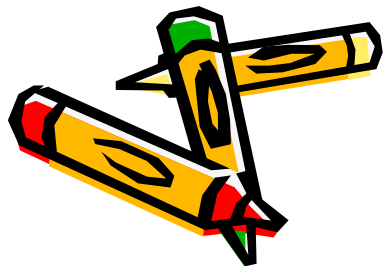
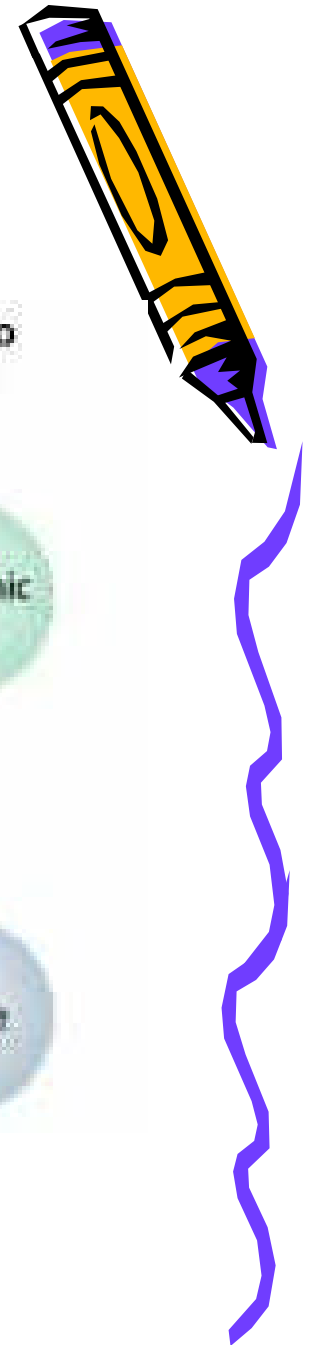
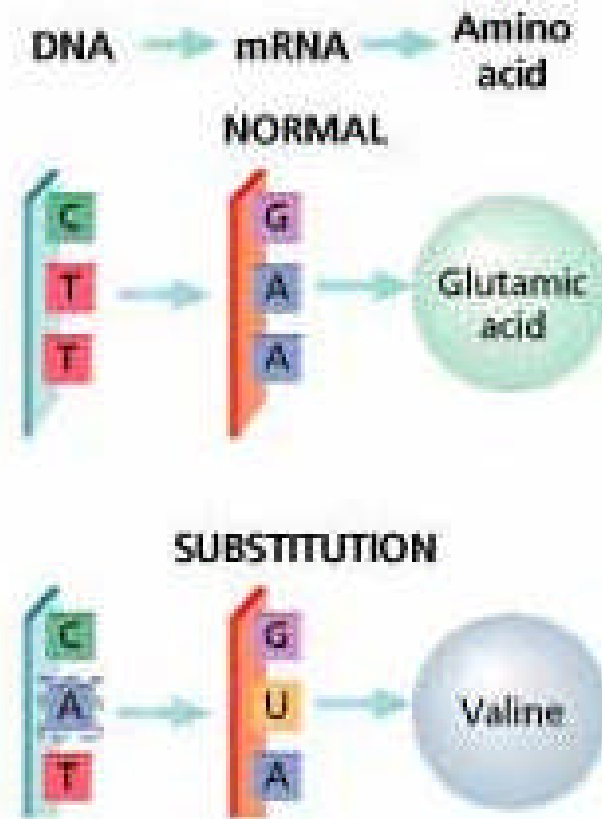


- **Mutation:** a permanent change in the DNA of an organism
- There are different types of mutations
  - Point Mutations
  - Frame shift Mutations



# Point Mutations

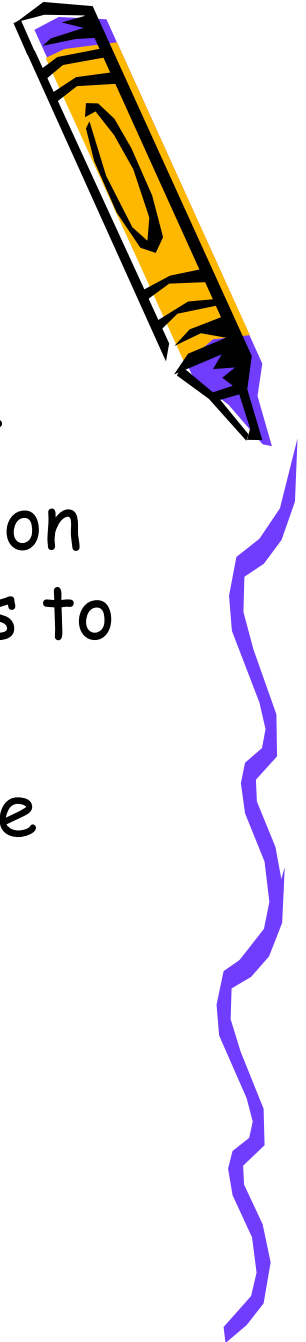
- Point Mutation: the substitution, addition, or removal of a single nucleotide
- Substitution can change the amino acid sequence of the protein or insert a premature stop codon

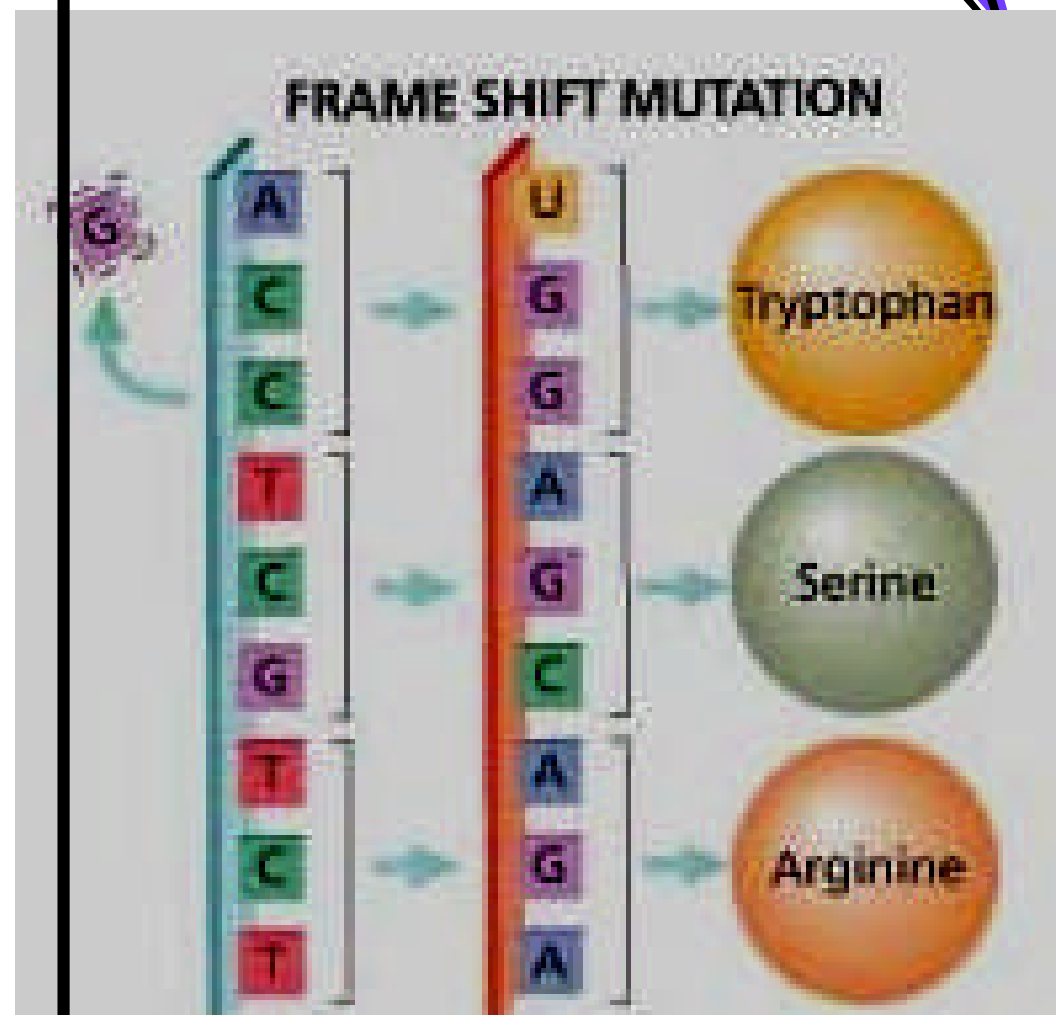
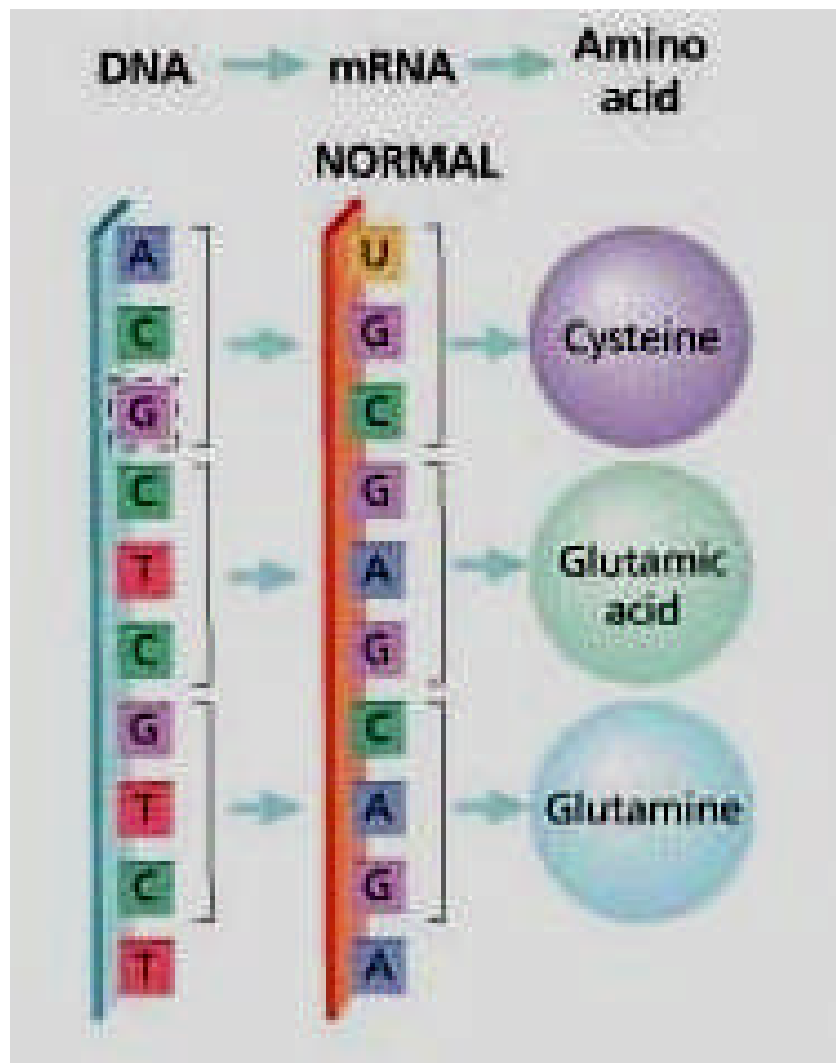


Sickle Cell Anemia is caused by a point mutation

# Frame Shift Mutation

- Frame Shift Mutation: A type of point mutation in which the addition or deletion of a single nucleotide causes the codons to be incorrectly grouped
- If this type of mutation occurs near the beginning of the gene it will prevent a number of codons from coding for the proper amino acids





# Self Check

- How is RNA different from DNA?
- What is the purpose of transcription?
- What is the purpose of translation?
- What is a codon?
- What is the result of a point mutation?

