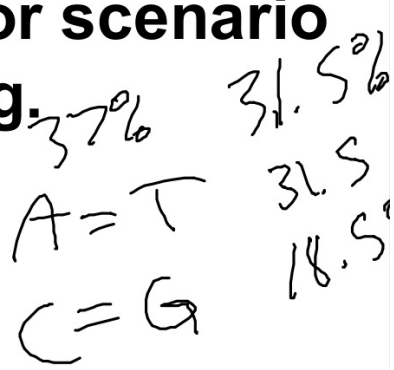
SPI 4.1: I can identify the structure and function of DNA.

Kickoff:

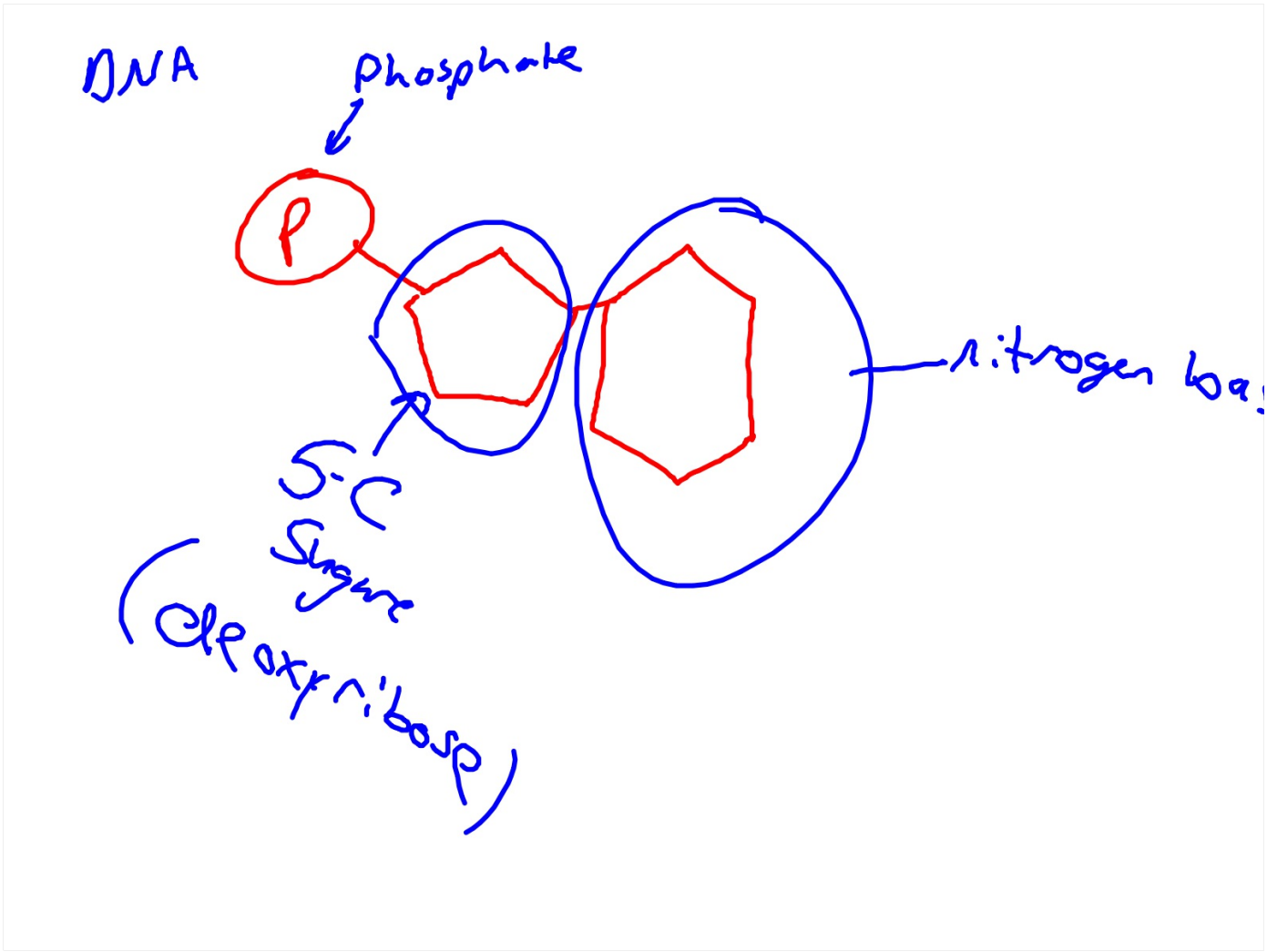
nucleic acid:polymer:: _____:monomer

Recall from standard 1.3, define what a nucleotide is with an illustration.

SPI Inq.1 Select a description or scenario that extends a scientific finding.



Frederick Griffith (1931)
Oswald Avery (1940s)
Edwin Chargaff (1940s)
Alfred Hershey/Martha Chase (1952)
Rosalind Franklin/ M.H.F. Wilkens (1950s)
Watson and Crick (1950s)


DNA
Phosphate
P
nitrogen ba
5-C
Sugar
(deoxyribosp)

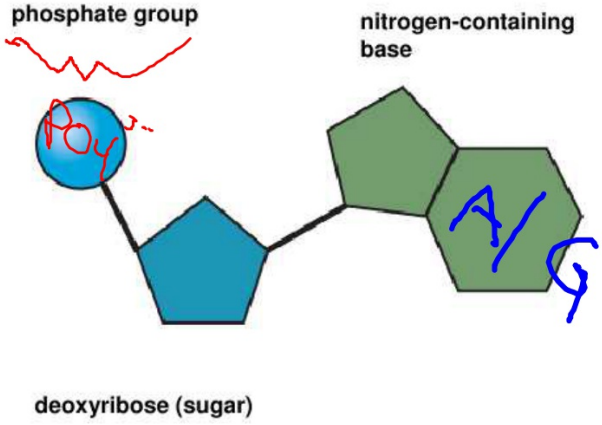
8.2 Structure of DNA

KEY CONCEPT

DNA structure is the same in all organisms.

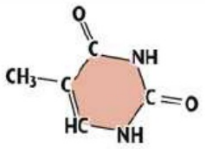
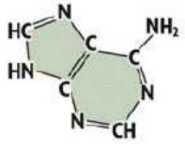
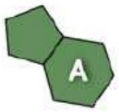
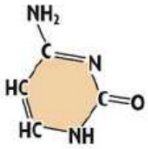
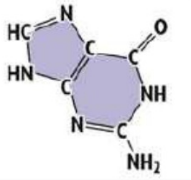
8.2 Structure of DNA

- **DNA is composed of four types of nucleotides.**
  - DNA is made up of a long chain of nucleotides.
  - Each nucleotide has three parts.
    - a phosphate group
    - a deoxyribose sugar
    - a nitrogen-containing base



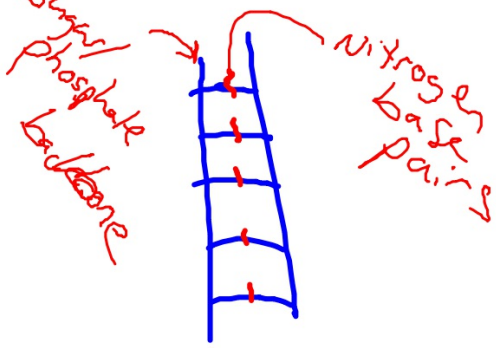
8.2 Structure of DNA

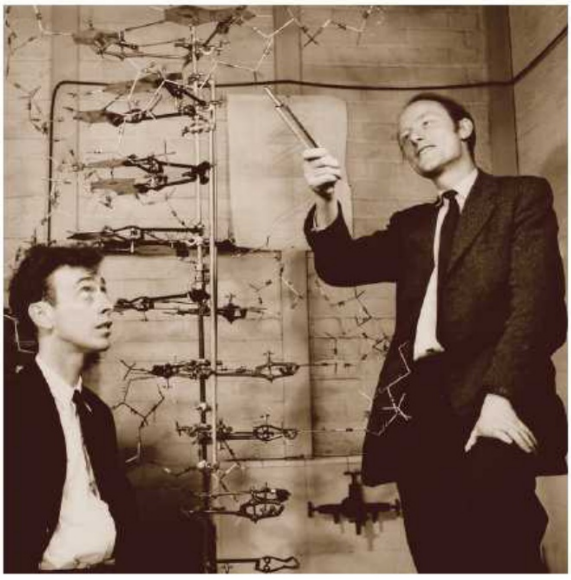
- The nitrogen containing bases are the only difference in the four nucleotides.

PYRIMIDINES = SINGLE RING			PURINES = DOUBLE RING		
Name of Base	Structural Formula	Model	Name of Base	Structural Formula	Model
thymine			adenine		
cytosine			guanine		

8.2 Structure of DNA

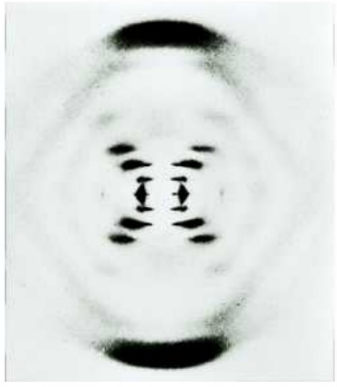
- **Watson and Crick determined the three-dimensional structure of DNA by building models.**
  - ~~They~~ realized that DNA is a double helix that is made up of a sugar-phosphate backbone on the outside with bases on the inside.





8.2 Structure of DNA

- Watson and Crick's discovery built on the work of Rosalind Franklin and Erwin Chargaff.
  - Franklin's x-ray images suggested that DNA was a double helix of even width.
  - Chargaff's rules stated that A=T and C=G.



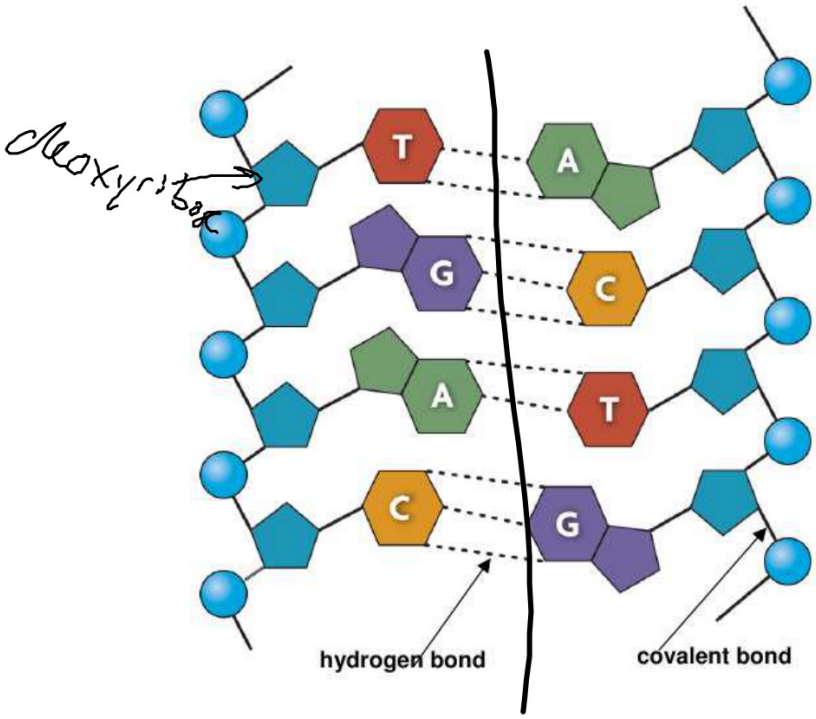
8.2 Structure of DNA

Nucleotides always pair in the same way.

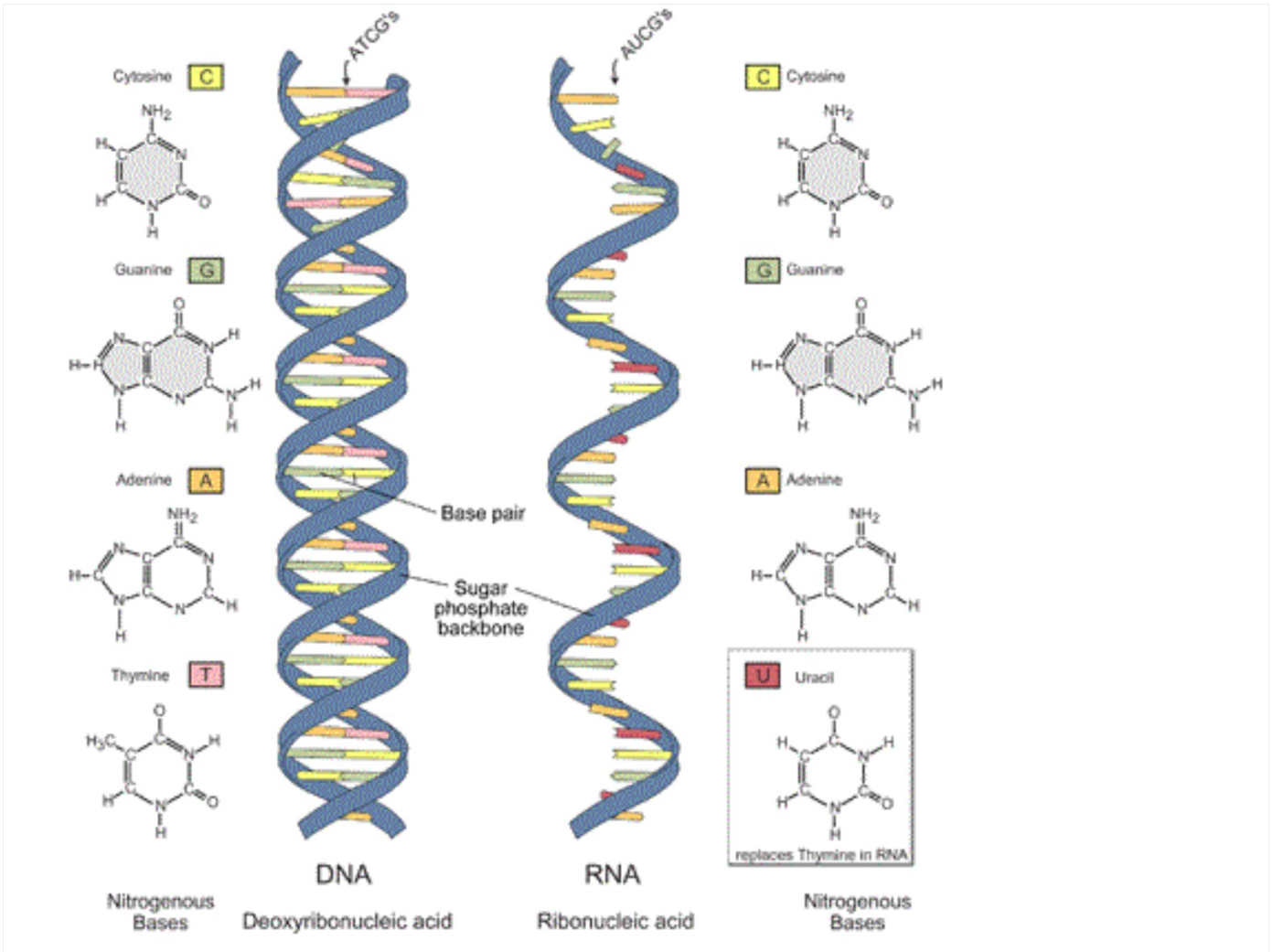
- The base-pairing rules show how nucleotides always pair up in DNA.
  - A pairs with T
  - C pairs with G
- Because a pyrimidine (single ring) pairs with a purine (double ring), the helix has a uniform width.

8.2 Structure of DNA

- The backbone is connected by covalent bonds.
- The bases are connected by hydrogen bonds.



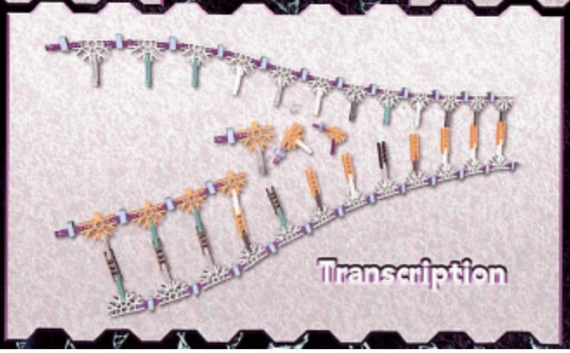
A=T
2+
G=C 3


ATCG's
AUCG's
Cytosine C
Guanine G
Adenine A
Thymine T
Base pair
Sugar phosphate backbone
C Cytosine
G Guanine
A Adenine
U Uracil
replaces Thymine in RNA
DNA
Deoxyribonucleic acid
RNA
Ribonucleic acid
Nitrogenous Bases
Nitrogenous Bases

78780

DNA, Replication and Transcription

K'Nex education



DNA, Replication and Transcription

DNA *(deoxyribonucleic acid)* and mRNA *(messenger ribonucleic acid)* molecules are both made up of nucleotide units bonded together in long chains. DNA nucleotides are made up of three sub-units: deoxyribose sugars, nitrogen-containing bases and phosphate groups. Similarly, mRNA nucleotides are made up of ribose sugars, nitrogen-containing bases and phosphate groups.

Two strands *(long chains)* of DNA bond together and wrap around each other to form the classic, double helix structure discovered by Watson and Crick. The long chain of mRNA remains as a single strand after it has been transcribed from a DNA double helix.

K'NEX Education uses distinct K'NEX pieces and color-coding to represent the various molecules and bonds that form DNA and mRNA. Use the following nucleotide "Key" to determine which K'NEX pieces you will need for the DNA and mRNA models you will build as part of this series of activities.

Component parts:

DNA pieces

Deoxyribose Sugar *(use in parent strand)*

Two (2) H-Bonds

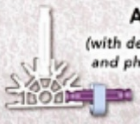
Three (3) H-Bonds

Thymine *(nitrogen-containing base)*

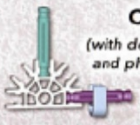
Deoxyribose Sugar
(substitute yellow Connectors for the gray Connectors to form a daughter strand)

Key:

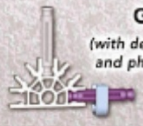
NUCLEOTIDES
(named for the nitrogen-containing base they include)



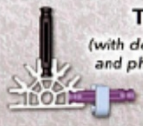
Adenine
(with deoxyribose sugar and phosphate group)



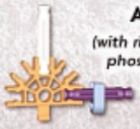
Cytosine
(with deoxyribose sugar and phosphate group)



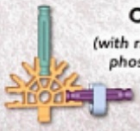
Guanine
(with deoxyribose sugar and phosphate group)



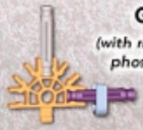
Thymine
(with deoxyribose sugar and phosphate group)



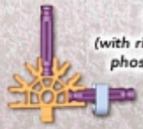
Adenine
(with ribose sugar and phosphate group)



Cytosine
(with ribose sugar and phosphate group)

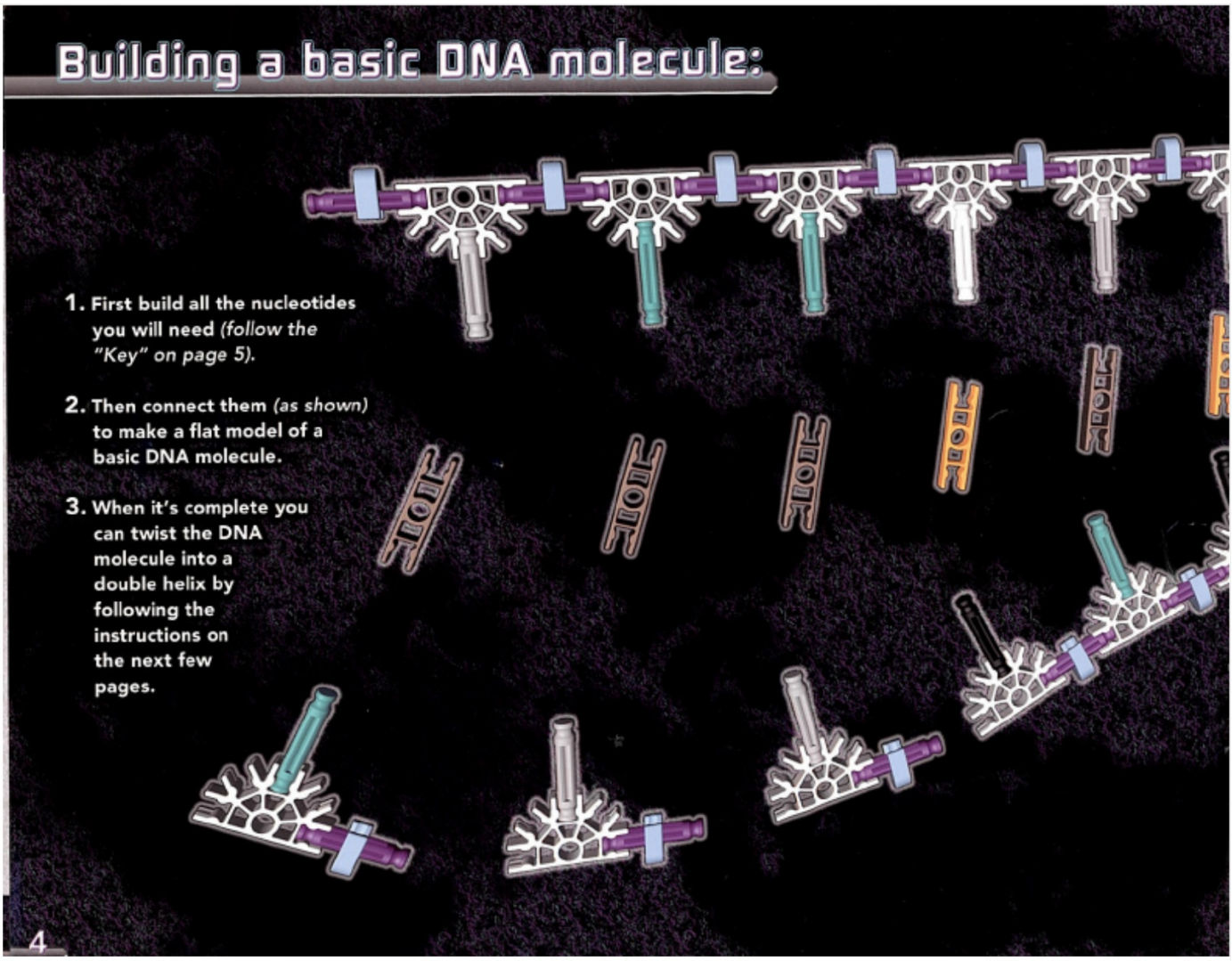


Guanine
(with ribose sugar and phosphate group)



Uracil
(with ribose sugar and phosphate group)

Building a basic DNA molecule:



1. First build all the nucleotides you will need *(follow the "Key" on page 5).*

2. Then connect them *(as shown)* to make a flat model of a basic DNA molecule.

3. When it's complete you can twist the DNA molecule into a double helix by following the instructions on the next few pages.


This is the basic DNA molecule.
Key: Nucleotides
7
7
5
5
7
5

Form the DNA molecule into a double helix:

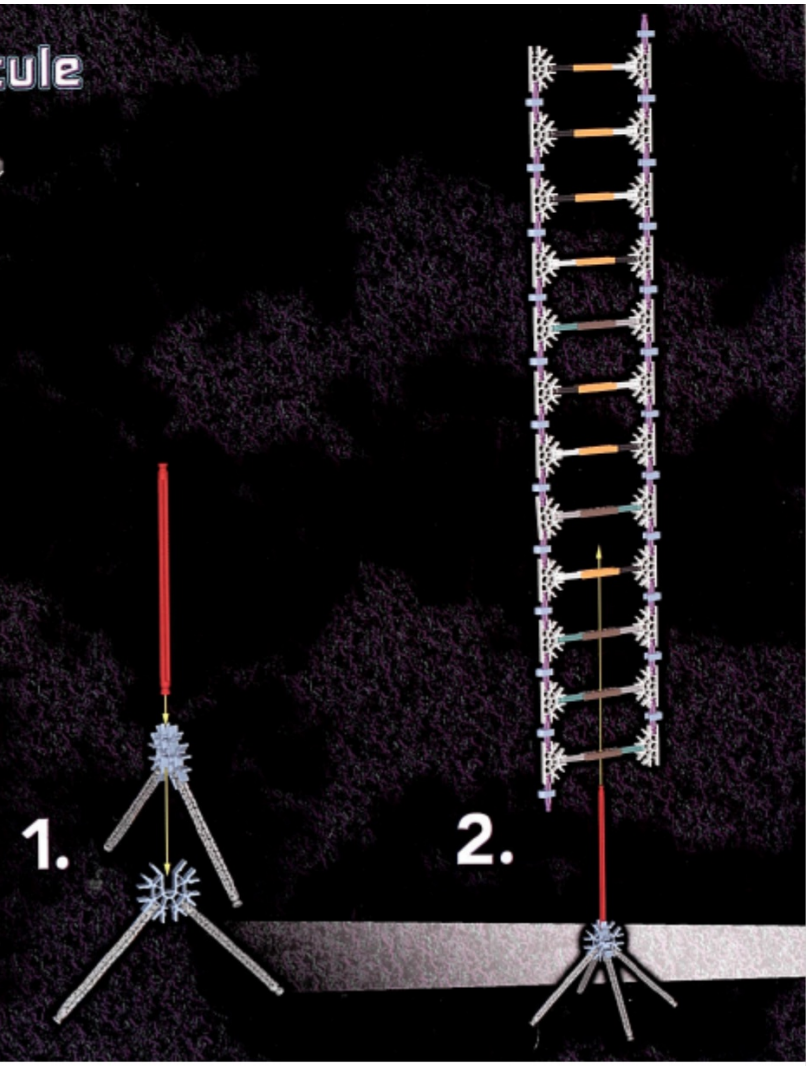
1. Build a display stand with one red Rod on it to start. Make sure the 2 light blue Connectors "click" when you put them together.

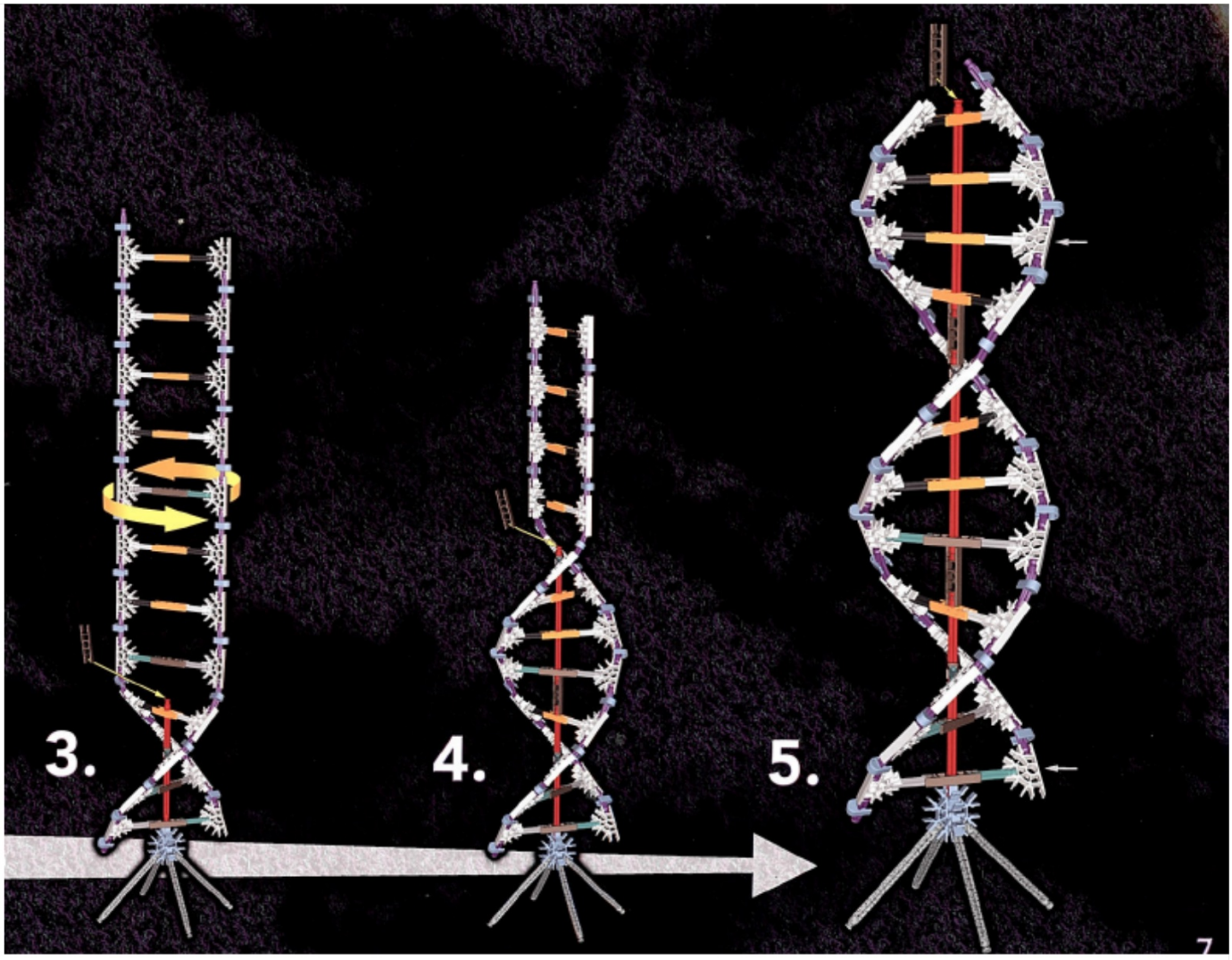
2. Rotate all of the orange and brown *(H-bonds)* Connectors so that the holes point down to align with the red Rod on the display stand.

3. Push the flat DNA molecule down as you thread the first 4 middle Connectors *(3 brown, 1 orange)* over the red Rod. Twist the DNA molecule as you push it down over the red Rod *(as shown)*. Add one brown Connector to hold the first 4 middle Connectors in the twisted position.

4. Repeat Step 3, using a second red Rod and brown Connector to hold the next 4 middle Connectors in the twisted position.

5. Repeat Step 3 again, using a third red Rod and brown Connector to complete the double helix on a stand.




3.
4.
5.

1. What are the THREE common parts of a nucleotide?_____

_____

2. What is the ONE part of a nucleotide that differs among the four DIFFERENT nucleotides in your

group?_____

3. List the four different kinds of nitrogen bases.

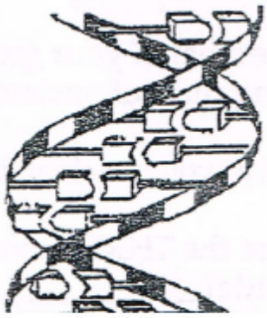
_____

_____

3. In the space below, use the letters to show the sequence (order) of the bases in the DNA molecule that your group constructed. Begin at the top left side of your molecule.

_____ goes with _____

_____ goes with _____



(Student Page 2)

Are there always going to be an EQUAL number of guanine and cytosine molecules in a molecule of

1. DNA? _____ Why?

_____

2. Scientists abbreviate the nitrogen bases by using the first letter of each base. So,

A always binds to ____

G always binds to ____

4. The sides (or "uprights") of the ladder are made up of alternating _____ and _____ molecules. The steps (or "rungs") of the ladder are made of _____ held together by HYDROGEN BONDS.

Kickoff:

Write out the complementary DNA sequence to the following gene:

5' G T C A C C T G A A T G C 3'

Take Survey on Blackboard called: MHS 10th grade registration on Blackboard.

Kickoff:

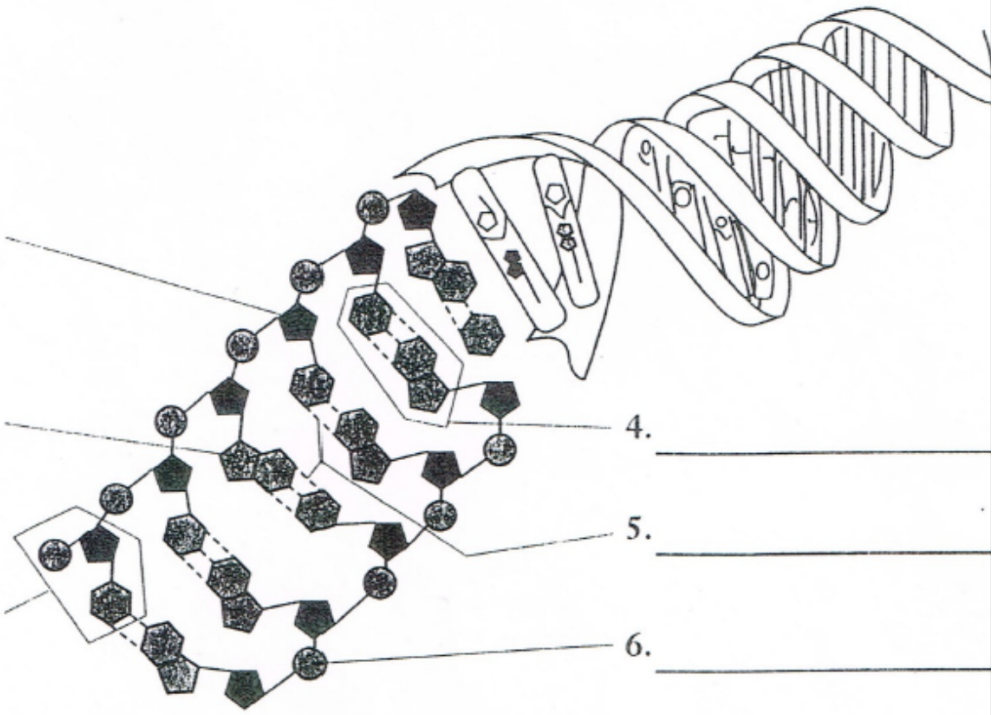
Take Survey on Blackboard called: MHS 10th grade registration on Blackboard.

Write out the complementary DNA sequence to the following gene:

5' GATTACATGGCAAATCATGC 3'

If a DNA strand is 20% guanine, how much of it is adenine?

DNA Quiz



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

7. Write out the four nitrogen bases of DNA:

Purines

a)

b)

Pyrimidines

c)

d)

8. A bonds with ____ by ____ (number) hydrogen bond

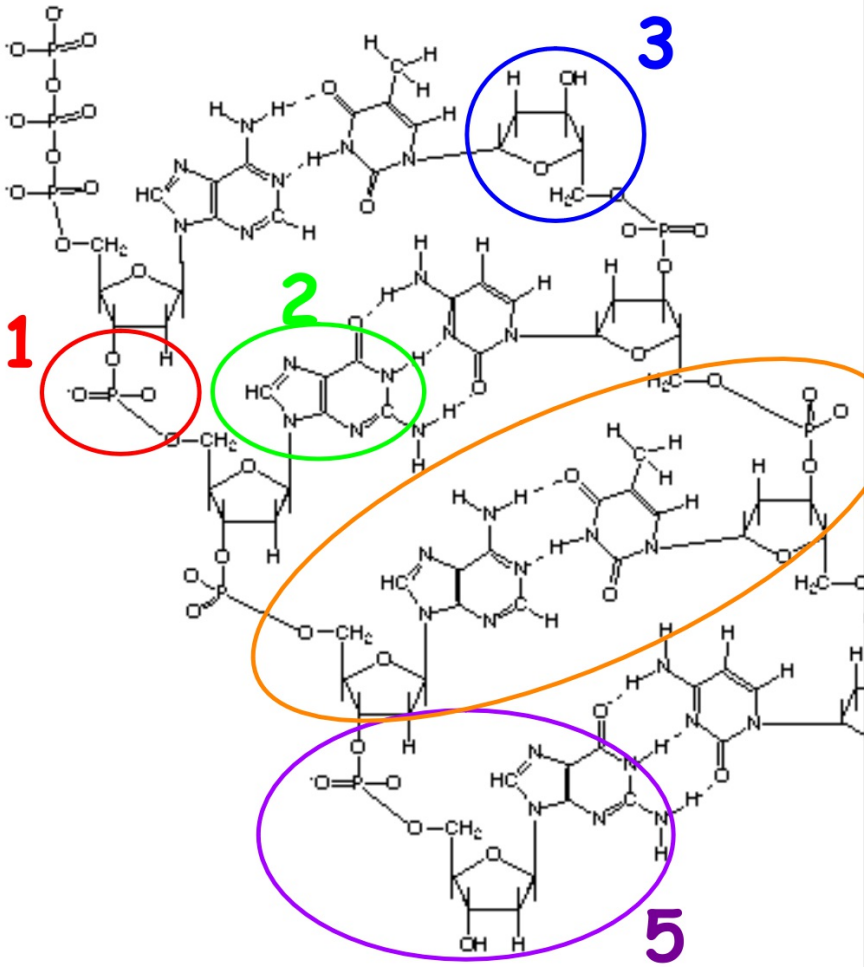
9. G bonds with ____ by ____ (number) hydrogen bond

10. The "backbone" of DNA is comprised of which two parts?

Kickoff:

Identify with as much detail as possible

1.
2.
3.
4.
5.



8.3 DNA Replication

KEY CONCEPT

DNA replication copies the genetic information of a cell.

DNA aka:

deoxyribonucleic acid

twisted ladder

genes

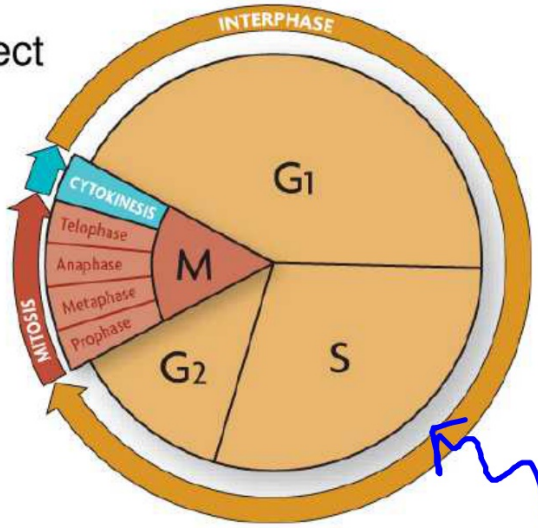
double helix

genetic code

#6 genome (complete sequence

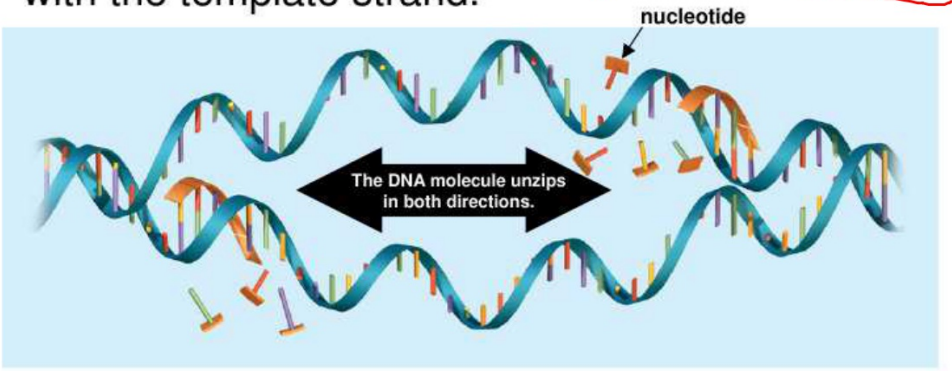
8.3 DNA Replication

- **Replication copies the genetic information.**
  - A single strand of DNA serves as a template for a new strand.
  - The rules of base pairing direct replication.
  - DNA is replicated during the S (synthesis) stage of the cell cycle.
  - Each ~~body~~ somatic cell gets a complete set of identical DNA.



8.3 DNA Replication

- **Proteins carry out the process of replication.**
  - DNA serves only as a template.
  - Enzymes and other proteins do the actual work of replication.
    - Enzymes unzip the double helix.
    - Free-floating nucleotides form hydrogen bonds with the template strand.

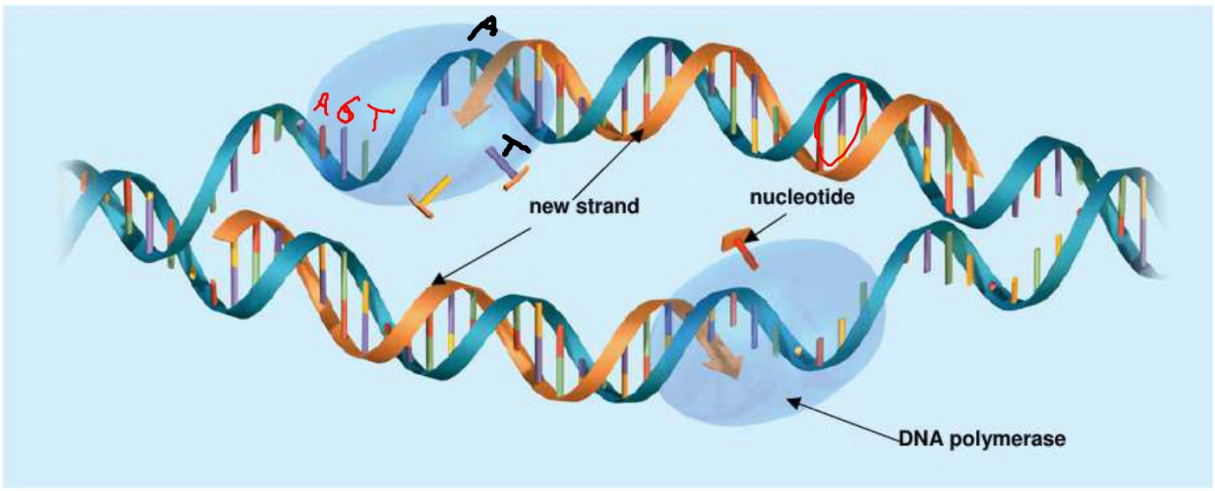


8.3 DNA Replication

semiconservative

- DNA polymerase enzymes bond the nucleotides together to form the double helix.
- Polymerase enzymes form covalent bonds between nucleotides in the new strand. → sugar/phosphate

50 b

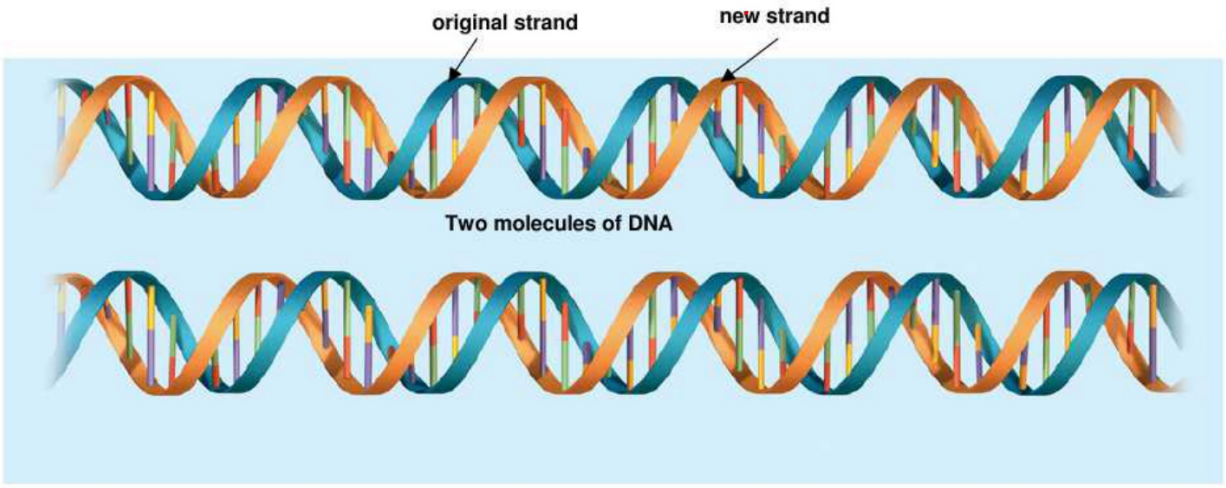


8.3 DNA Replication

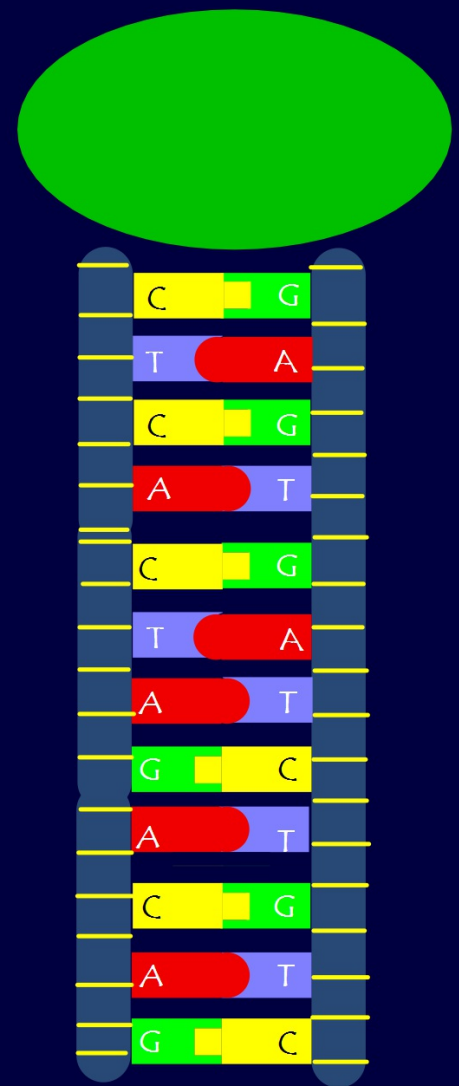
Semiconservative replication –

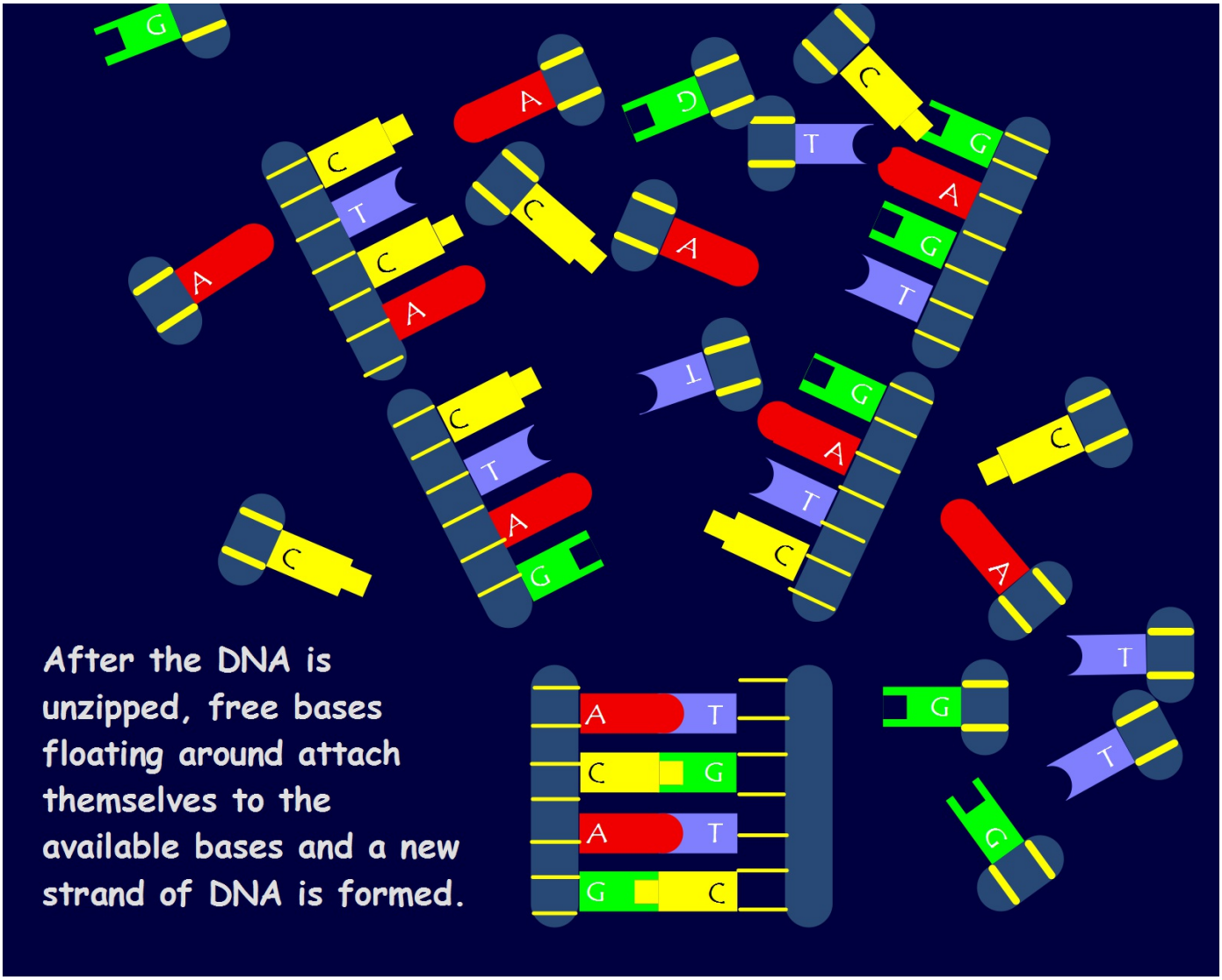
- Two new molecules of DNA are formed, each with an original strand and a newly formed strand.
- DNA replication is semiconservative.

So by



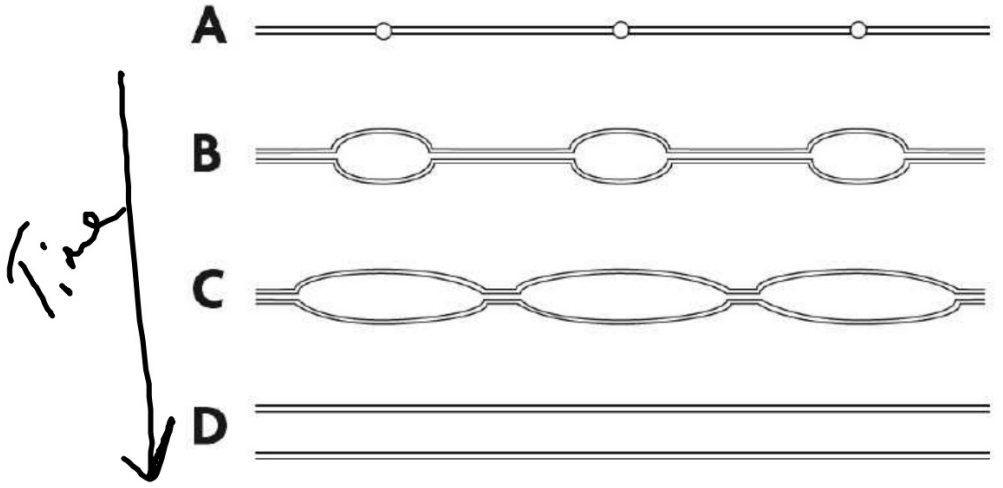
During interphase, the chromosomes in a nucleus duplicate. How? An enzyme attaches itself to the DNA strand and it literally unzips the DNA strand.




After the DNA is unzipped, free bases floating around attach themselves to the available bases and a new strand of DNA is formed.

Replication is fast and accurate.

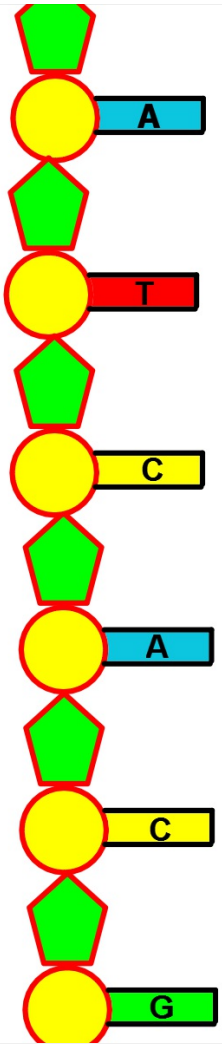
- DNA replication starts at many points in eukaryotic chromosomes.



There are many origins of replication in eukaryotic chromosomes.

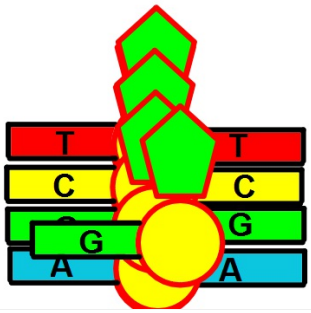
- DNA polymerases can find and correct errors.

DNA Replication



Phosphate

Sugar



DNA Replication

match the base with its complement

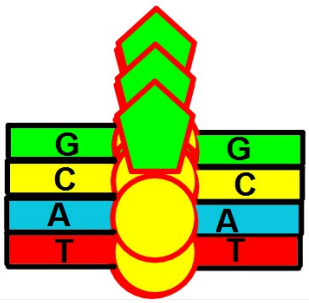
A T C C G A

A T C G

DNA Replication

G A C T CC A G T

A T C G


G
C
A
T
G
C
A
T

Kickoff:

1. What are the three components of central dogma?

2. Which components of central dogma describe how proteins are made?

3. What is a monomer of a protein?

Kickoff: Translate the amino acid sequence

Plant species A	DNA base sequence	AAC	CCA	AGT	GGA
	mRNA base sequence				
	amino acid sequence	_____	_____	_____	_____

Universal Genetic Code Chart
Messenger RNA Codons and the Amino Acids for Which They Code

FIRST BASE	SECOND BASE: U	SECOND BASE: C	SECOND BASE: A	SECOND BASE: G	THIRD BASE
U	UUU, UUC: PHE UUA, UUG: LEU	UCU, UCC, UCA, UCG: SER	UAU, UAC: TYR UAA, UAG: STOP	UGU, UGC: CYS UGA: STOP UGG: TRP	U C A G
C	CUU, CUC, CUA, CUG: LEU	CCU, CCC, CCA, CCG: PRO	CAU, CAC: HIS CAA, CAG: GLN	CGU, CGC, CGA, CGG: ARG	U C A G
A	AUU, AUC, AUA: ILE AUG: MET or START	ACU, ACC, ACA, ACG: THR	AAU, AAC: ASN AAA, AAG: LYS	AGU, AGC: SER AGA, AGG: ARG	U C A G
G	GUU, GUC, GUA, GUG: VAL	GCU, GCC, GCA, GCG: ALA	GAU, GAC: ASP GAA, GAG: GLU	GGU, GGC, GGA, GGG: GLY	U C A G

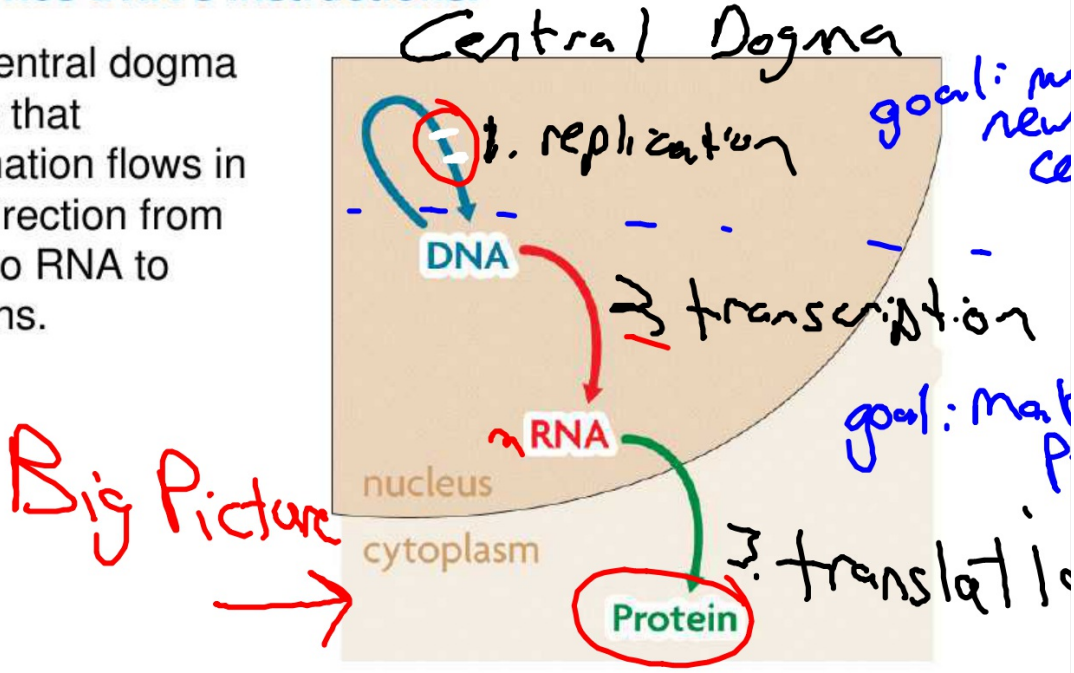
8.4 Transcription

KEY CONCEPT

Transcription converts a gene into a single-stranded RNA molecule.

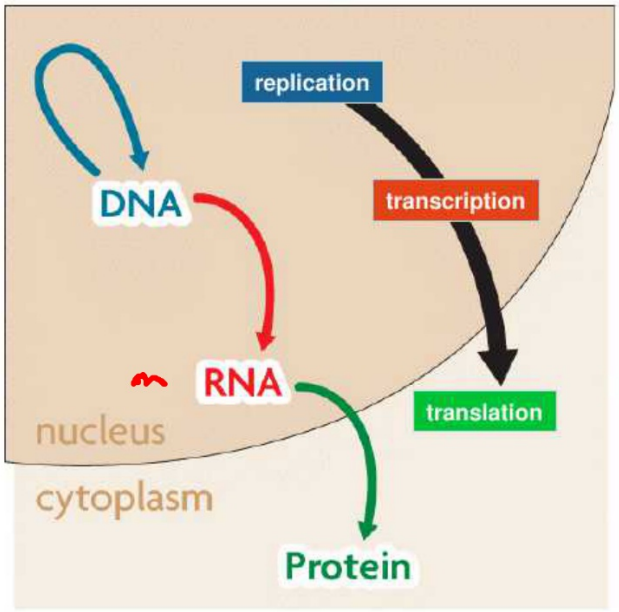
8.4 Transcription

- **RNA carries DNA's instructions.**
  - The central dogma states that information flows in one direction from DNA to RNA to proteins.



8.4 Transcription

- The central dogma includes three processes.
  1. – Replication
  2. – Transcription
  3. – Translation
- RNA is a link between DNA and proteins.



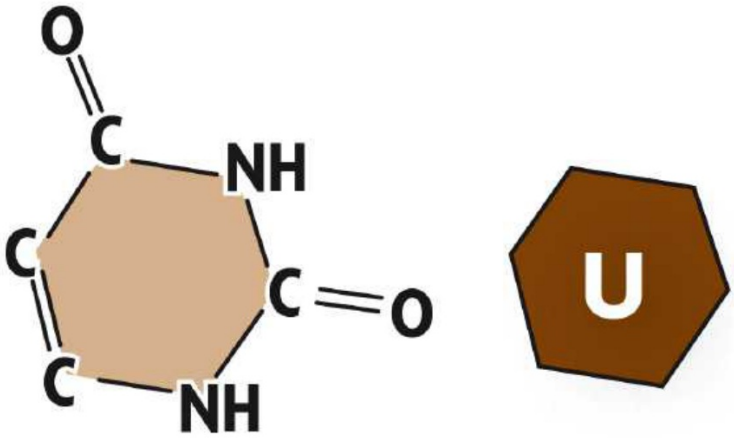
RNA (ribonucleic)
- Single acid stranded
- Uracil replacing thymine
- Sugar ribose

3 types of RNA

- messenger RNA (mRNA) co
- transfer RNA (tRNA) - transla
cipher
(co
- ribosomal RNA (rRNA) - site fo
reading
readi

8.4 Transcription

- RNA differs from DNA in three major ways.
  - RNA has a ribose sugar.
  - RNA has uracil instead of thymine. (U instead of T)
  - RNA is a single-stranded structure.



8.4 Transcription

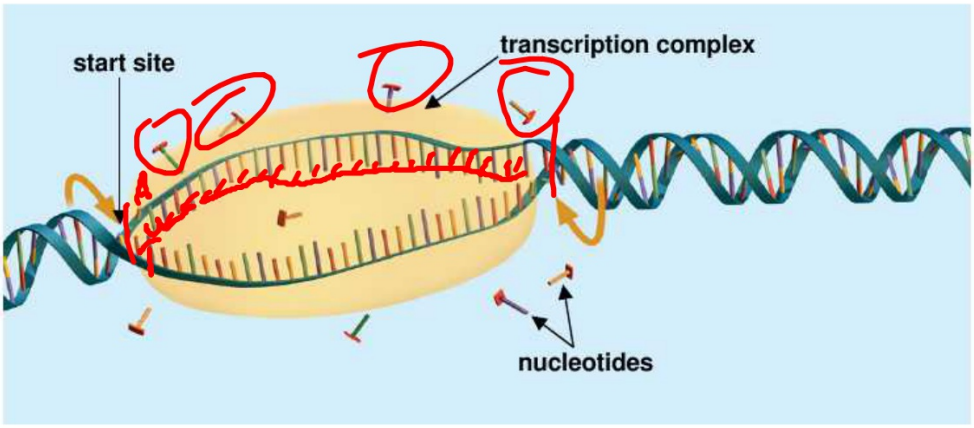
- **Transcription makes three types of RNA.**
  - Transcription copies DNA to make a strand of RNA.

Where? Nucleus

How?: 1. RNA polymerase (unwin
unz
2. Free nucleotides
Complementary base pairing
to make message (m

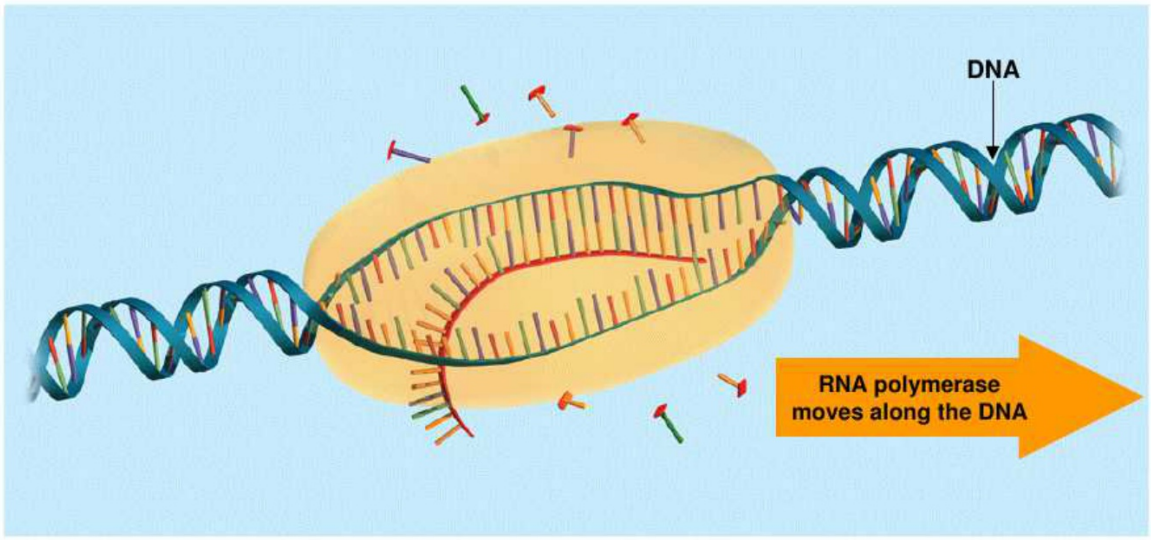
8.4 Transcription

- Transcription is catalyzed by RNA polymerase.
  - RNA polymerase and other proteins form a transcription complex.
  - The transcription complex recognizes the start of a gene and unwinds a segment of it.



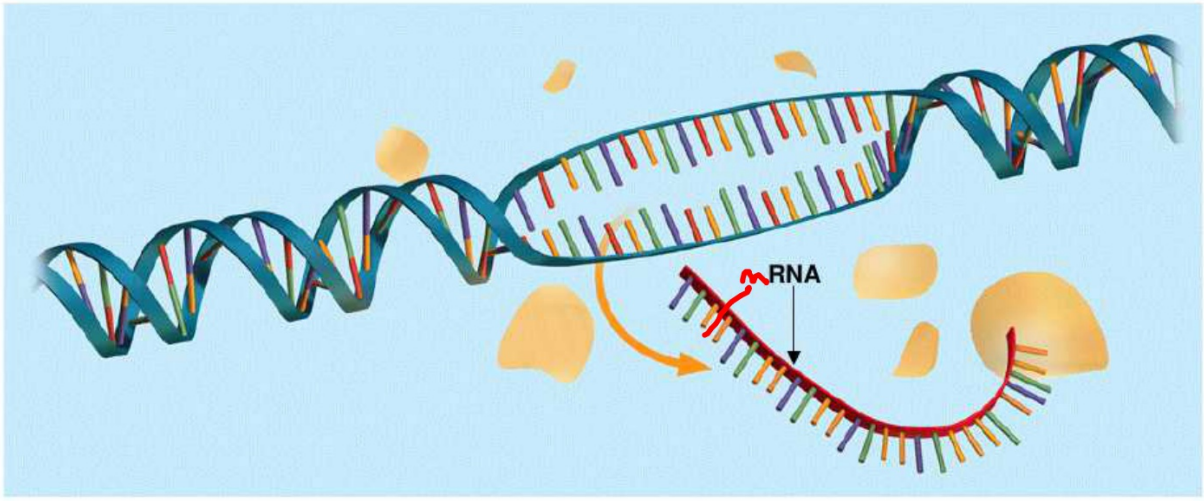
8.4 Transcription

– Nucleotides pair with one strand of the DNA.
– RNA polymerase bonds the nucleotides together.
– The DNA helix winds again as the gene is transcribed.



8.4 Transcription

– The RNA strand detaches from the DNA once the gene is transcribed.



8.4 Transcription

- Transcription makes three types of RNA.
  - Messenger RNA (mRNA) carries the message that will be translated to form a protein.
  - Ribosomal RNA (rRNA) forms part of ribosomes where proteins are made.
  - Transfer RNA (tRNA) brings amino acids from the cytoplasm to a ribosome.

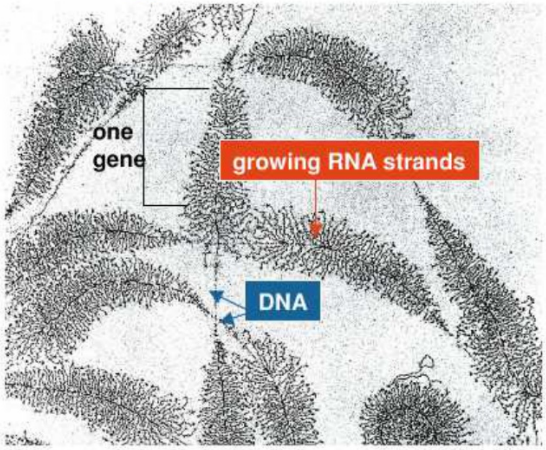
DNA: GATTACA

mRNA: CUAAUGU

8.4 Transcription

The transcription process is similar to replication.

- Transcription and replication both involve complex enzymes and complementary base pairing.
- The two processes have different end results.
  - Replication copies all the DNA; transcription copies a gene.
  - Replication makes one copy; transcription can make many copies.



Kickoff: Transcribe and translate the DNA sequence

5' TACTCTGGAATACCGACT 3

First Letter	Second Letter				Third Letter
	U	C	A	G	
U	phenylalanine	serine	tyrosine	cysteine	U
	phenylalanine	serine	tyrosine	cysteine	C
	leucine	serine	stop	stop	A
	leucine	serine	stop	tryptophan	G
C	leucine	proline	histidine	arginine	U
	leucine	proline	histidine	arginine	C
	leucine	proline	glutamine	arginine	A
	leucine	proline	glutamine	arginine	G
A	isoleucine	threonine	asparagine	serine	U
	isoleucine	threonine	asparagine	serine	C
	isoleucine	threonine	lysine	arginine	A
	(start) methionine	threonine	lysine	arginine	G
G	valine	alanine	aspartate	glycine	U
	valine	alanine	aspartate	glycine	C
	valine	alanine	glutamate	glycine	A
	valine	alanine	glutamate	glycine	G

SPI 4.3: Recognize the interactions between DN
and RNA during protein synthesis.

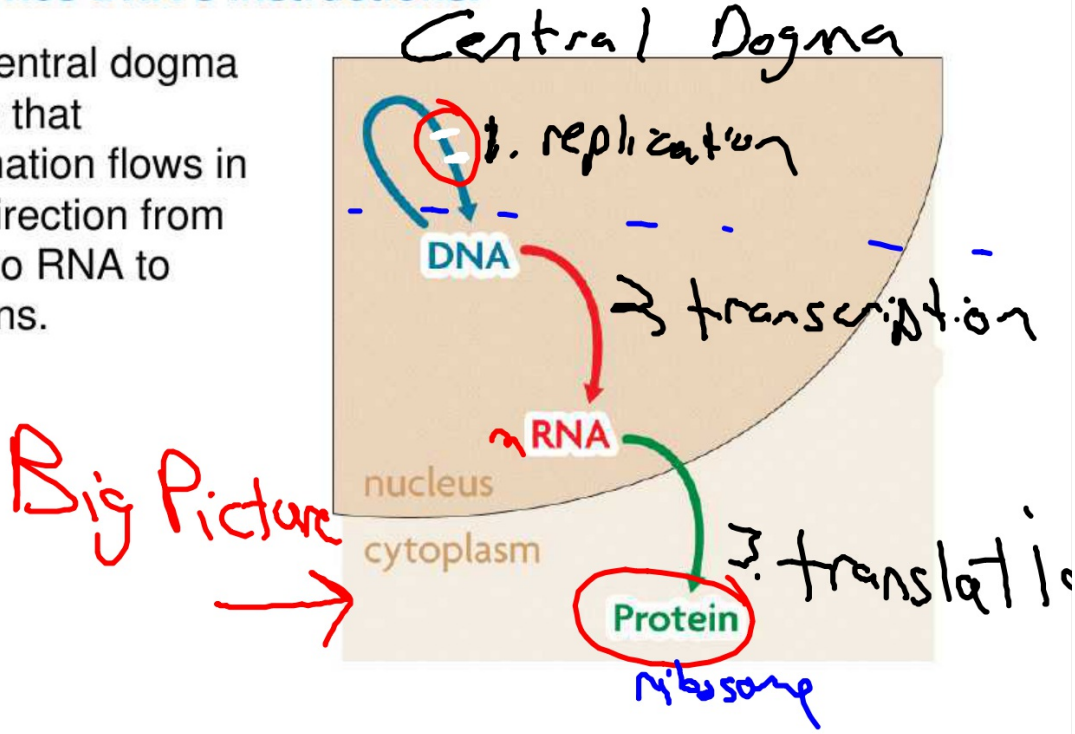
8.5 Translation

KEY CONCEPT

Translation converts an mRNA message into a polypeptide, or protein.

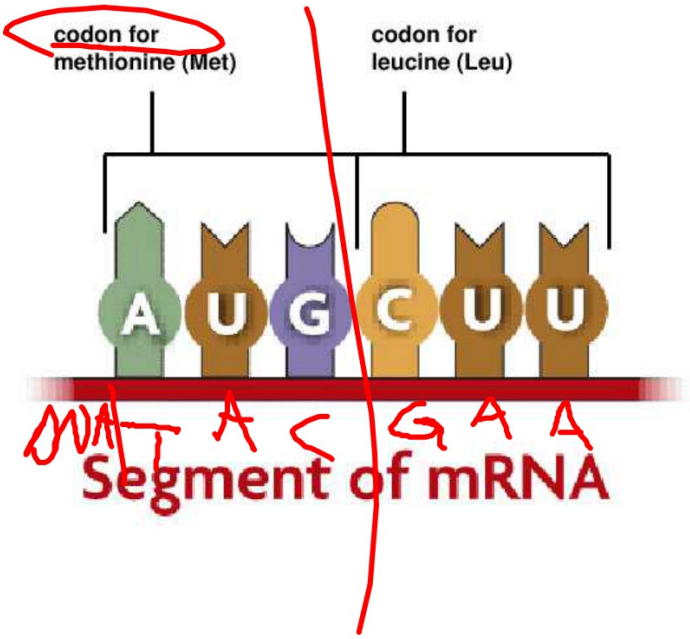
8.4 Transcription

- **RNA carries DNA's instructions.**
  - The central dogma states that information flows in one direction from DNA to RNA to proteins.



8.5 Translation

- **Amino acids are coded by mRNA base sequences.**
  - Translation converts mRNA messages into polypeptides.
  - A codon is a sequence of three nucleotides that codes for an amino acid. 20



8.5 Translation

- The genetic code matches each codon to its amino acid function.
  - three stop codons
  - one start codon, codes for methionine

UAU CGC AC
TYR ARG Thr

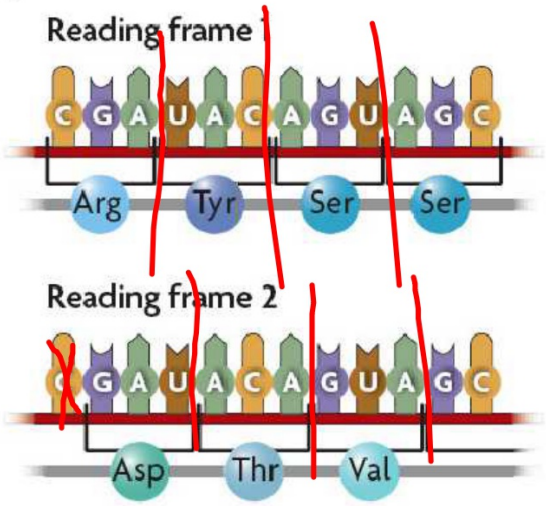
The genetic code matches each RNA **codon** with its amino acid or function.

First base	Second base U	Second base C	Second base A	Second base G	
U	phenylalanine (Phe)	serine (Ser)	tyrosine (Tyr)	cysteine (Cys)	U
	leucine (Leu)		STOP	STOP	A
			STOP	tryptophan (Trp)	G
C	leucine (Leu)	proline (Pro)	histidine (His)	arginine (Arg)	U
			glutamine (Gln)		C
					A
					G
A	isoleucine (Ile)	threonine (Thr)	asparagine (Asn)	serine (Ser)	U
			lysine (Lys)	arginine (Arg)	C
	methionine (Met)				A
G	valine (Val)	alanine (Ala)	aspartic acid (Asp)	glycine (Gly)	U
			glutamic acid (Glu)		C
					A
					G

1. Find the first base, C, in the left column.
2. Find the second base, A, in the top row. Find the box where these two intersect.
3. Find the third base, U, in the right column. CAU codes for histidine, abbreviated as His.

8.5 Translation

- A change in the order in which codons are read changes the resulting protein.

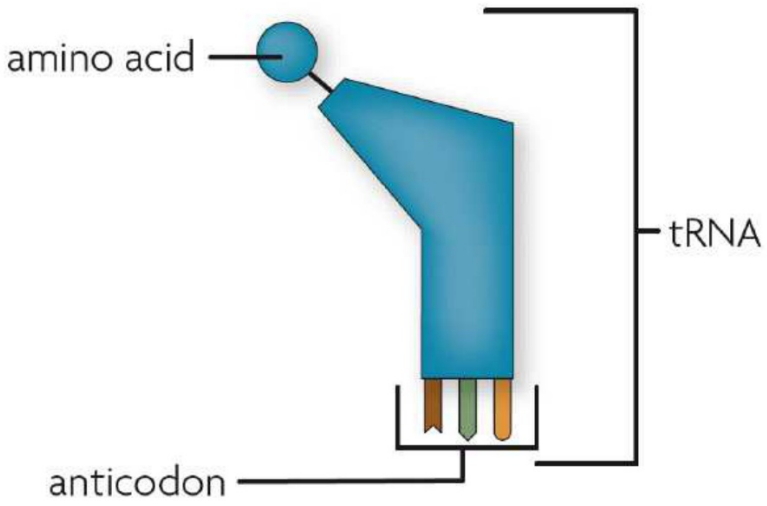


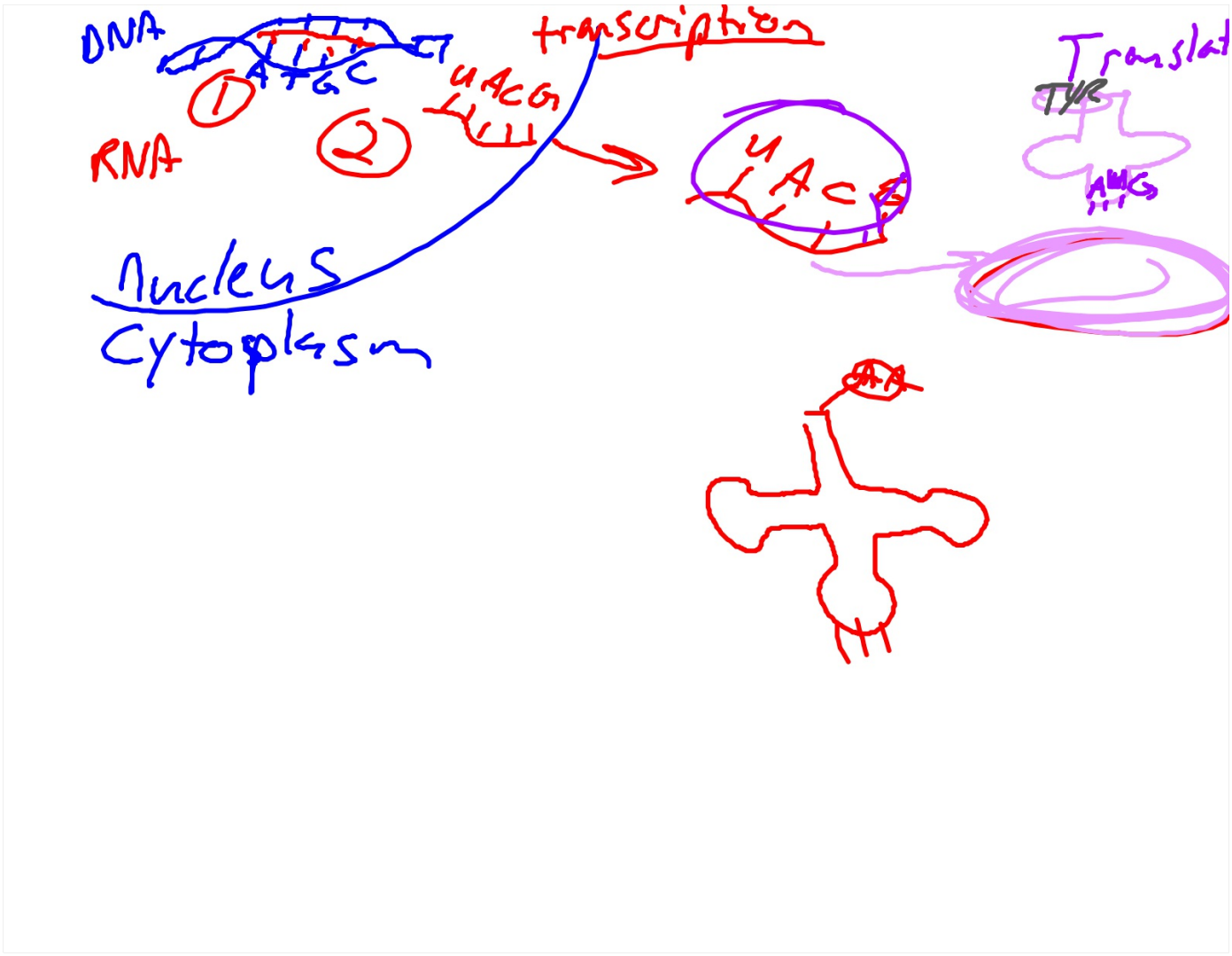
- Regardless of the organism, codons code for the same amino acid.

8.5 Translation

Amino acids are linked to become a protein.

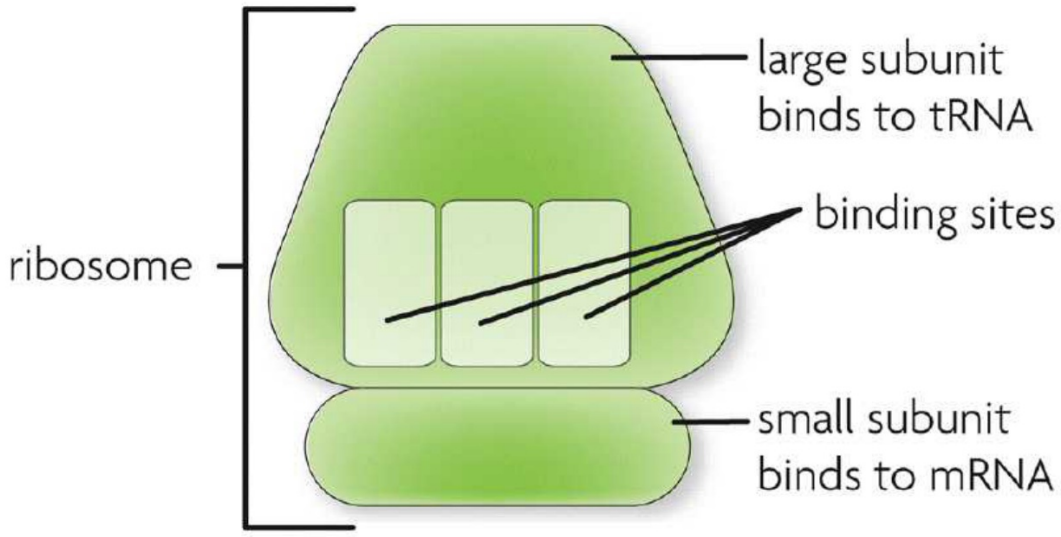
- An anticodon is a set of three nucleotides that is complementary to an mRNA codon.
- An anticodon is carried by a tRNA.




DNA
ATGC
1
2
RNA
UACG
transcription
Nucleus
Cytoplasm
UACG
Translat
TYR
AUG
AA

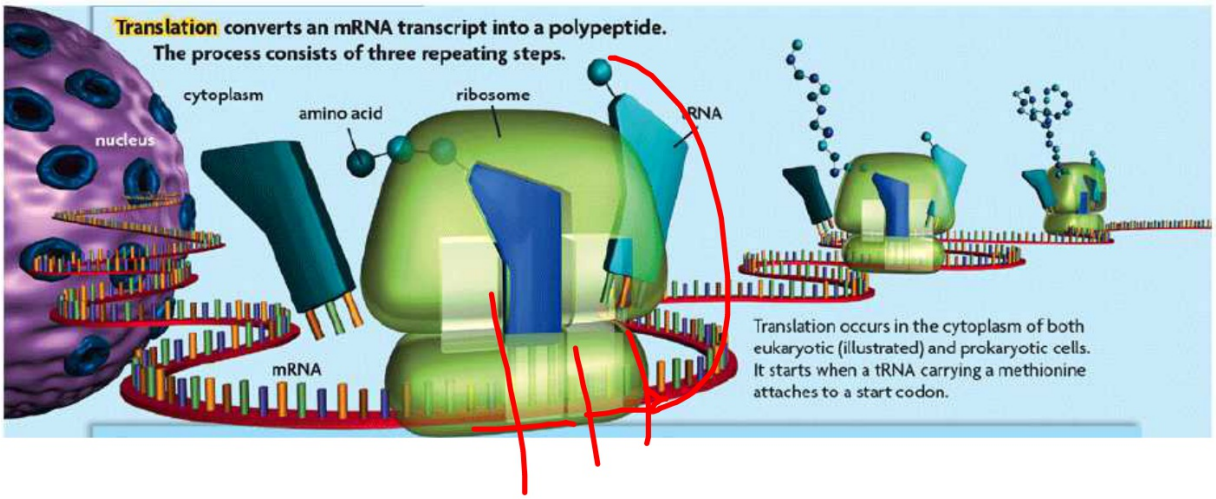
8.5 Translation

- Ribosomes consist of two subunits.
  - The large subunit has three binding sites for tRNA.
  - The small subunit binds to mRNA.



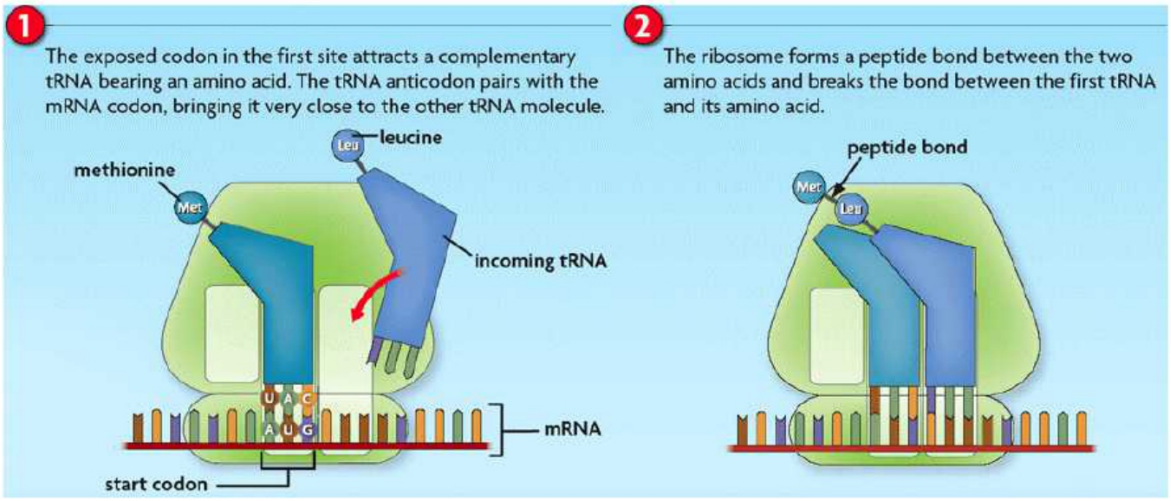
8.5 Translation

- For translation to begin, tRNA binds to a start codon and signals the ribosome to assemble.
  - A complementary tRNA molecule binds to the exposed codon, bringing its amino acid close to the first amino acid.



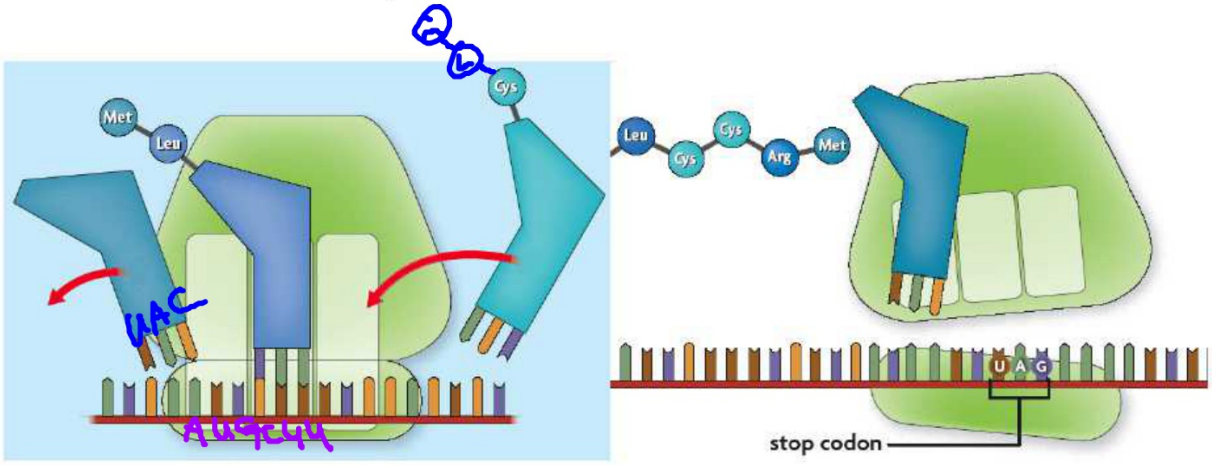
8.5 Translation

- The ribosome helps form a polypeptide bond between the amino acids.
- The ribosome pulls the mRNA strand the length of one codon.



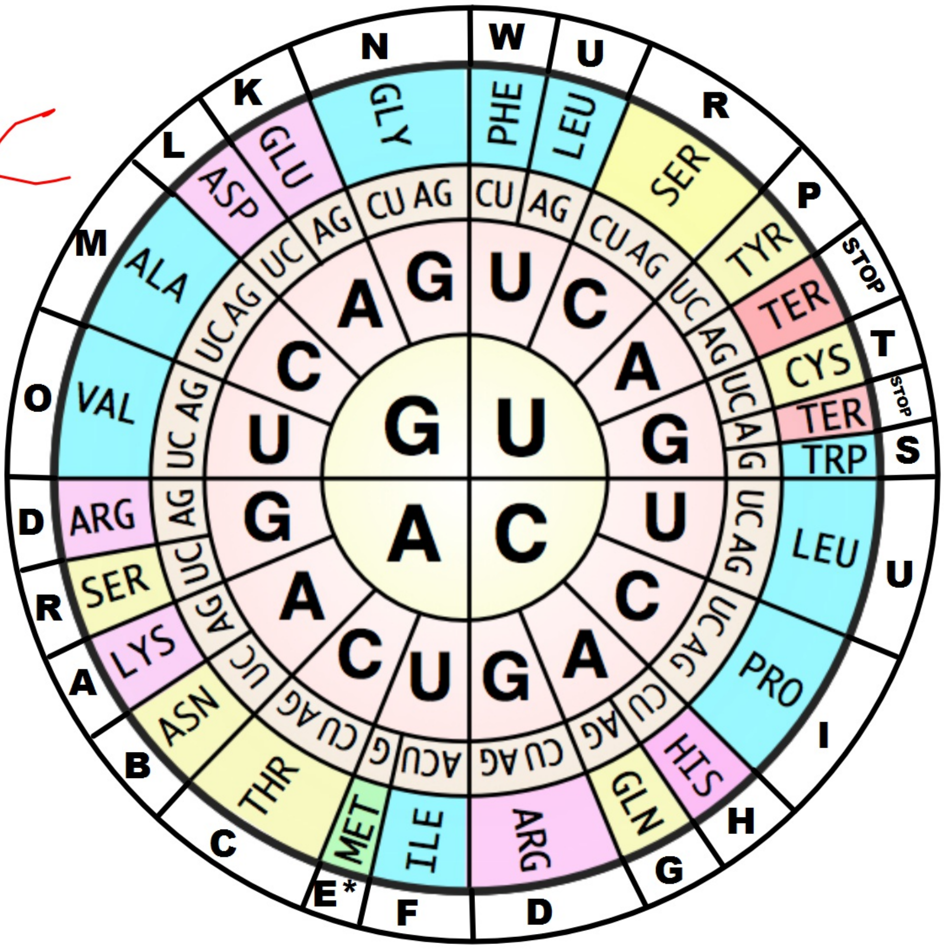
8.5 Translation

- The now empty tRNA molecule exits the ribosome.
- A complementary tRNA molecule binds to the next exposed codon.
- Once the stop codon is reached, the ribosome releases the protein and disassembles.



GAC

CGU

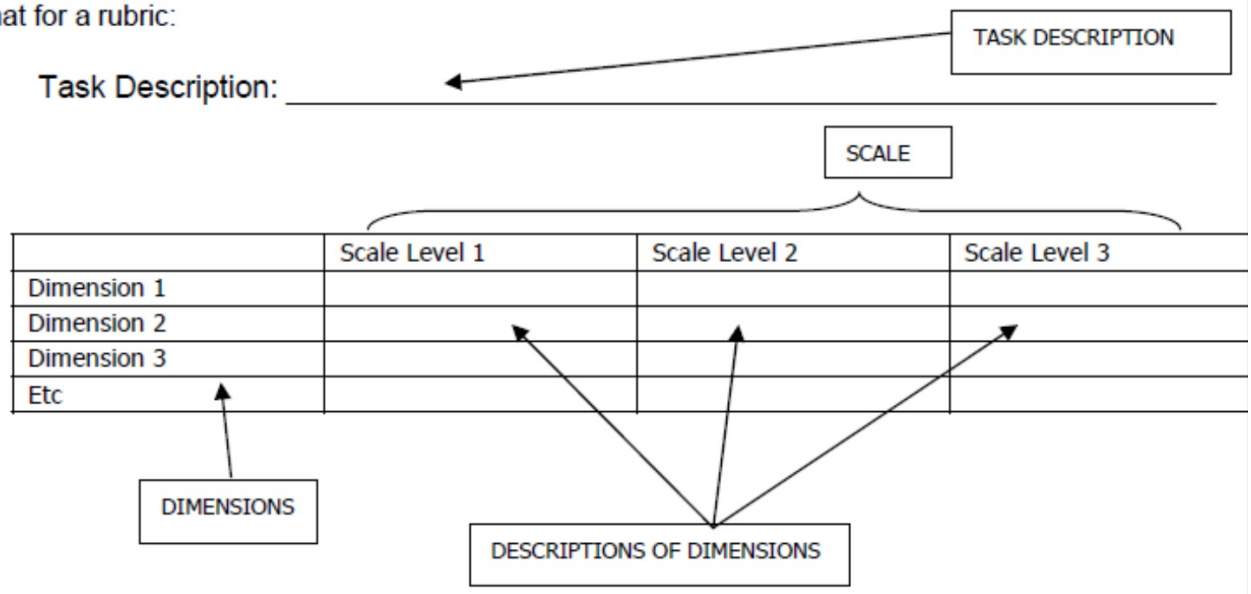

N
W
U
R
P
STOP
T
STOP
S
U
I
H
G
D
F
E*
C
B
A
R
D
O
M
L
K
GLY
PHE
LEU
SER
TYR
TER
CYS
TER
TRP
LEU
PRO
HIS
GLN
ARG
ILE
MET
THR
ASN
LYS
SER
ARG
VAL
ALA
ASP
GLU
G
U
A
C

Your goal: to successfully examine how we go from DN to proteins.

Develop a rubric: Task Description_____

Format for a rubric:

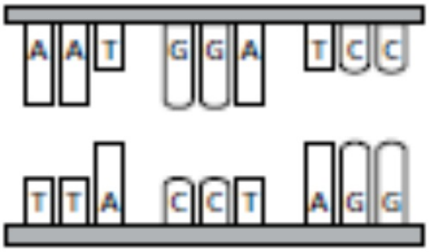
Task Description: _____



Parent DNA	Replicate DNA	mRNA	tRNA	Amino Acids
5’				
A				
G				
T				
A				
T				
G				
T				
T				
G				
T				
A				
A				
G				
C				
T				
3’				

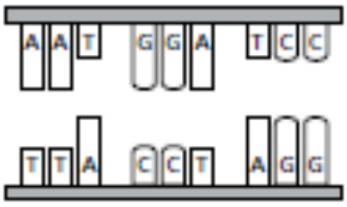
Parent DNA	Replicate DNA	mRNA	tRNA	Amino Acids
5’				
T				
A				
C				
T				
T				
C				
G				
T				
T				
C				
C				
A				
T				
T				
A				
3’				

The diagram below represents a DNA molecule.



Which of the following represents the DNA molecule that results from replication if no mutations occur?

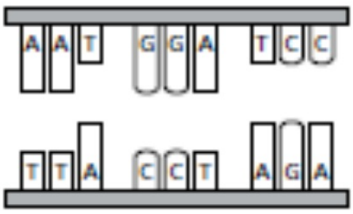
F



H

G

J



K	Glu	Glutamic acid
L	Asp	Aspartic acid
M	Ala	Alanine
N	Gly	Glycine
O	Val	Valine
none (or "Stop")	(none - a "Stop" code)	
P	Tyr	Tyrosine
R	Ser	Serine
S	Tryp	Tryptophane
T	Cys	Cysteine
U	Leu	Leucine
W	Phe	Phenylalanine

"F" or "start"

a) Using the mRNA triplet code units and the assigned English letter equivalents, translate the following two messages:

AUG/AGA/UCU/UAA/AUG/CAU/AUG/AAU/AUG/UCU/UGU/UAA/AUG/CCU/UGG/UAA/AUG/UGU/CAU/AUG/UAA/AUG/AAU/AUG/UGG/UGU/UAA!

AUG/AGA/GGU/AAA/UAA/AUG/CCU/UGG/UAA/AUG/UGU/CAU/AUG/UAA/AUG/ACU/GUU/AGA/AUG/UAA/AUG/GUU/AUU/UAA/AUG/GAU/CCU/AUU/AUG/UAA !

b) Go back and write out the amino acid sequence for the proteins coded above.