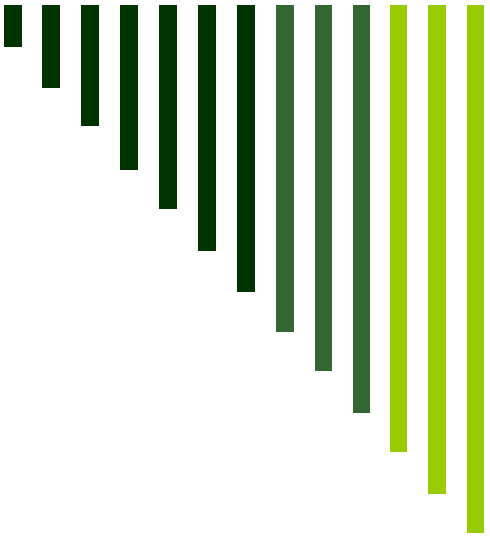


# DNA and RNA

## Replication, Transcription and Translation

# SB2b

- Students will analyze how biological traits are passed on to successive generations.

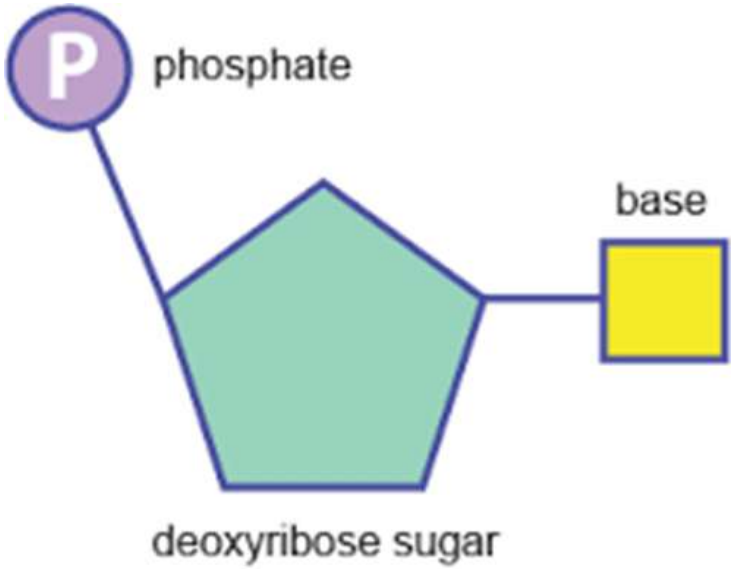
b. Explain the role of DNA in storing and transmitting cellular information

# Essential Question

- What is the role of DNA in the process of passing biological traits from one generation to the next?

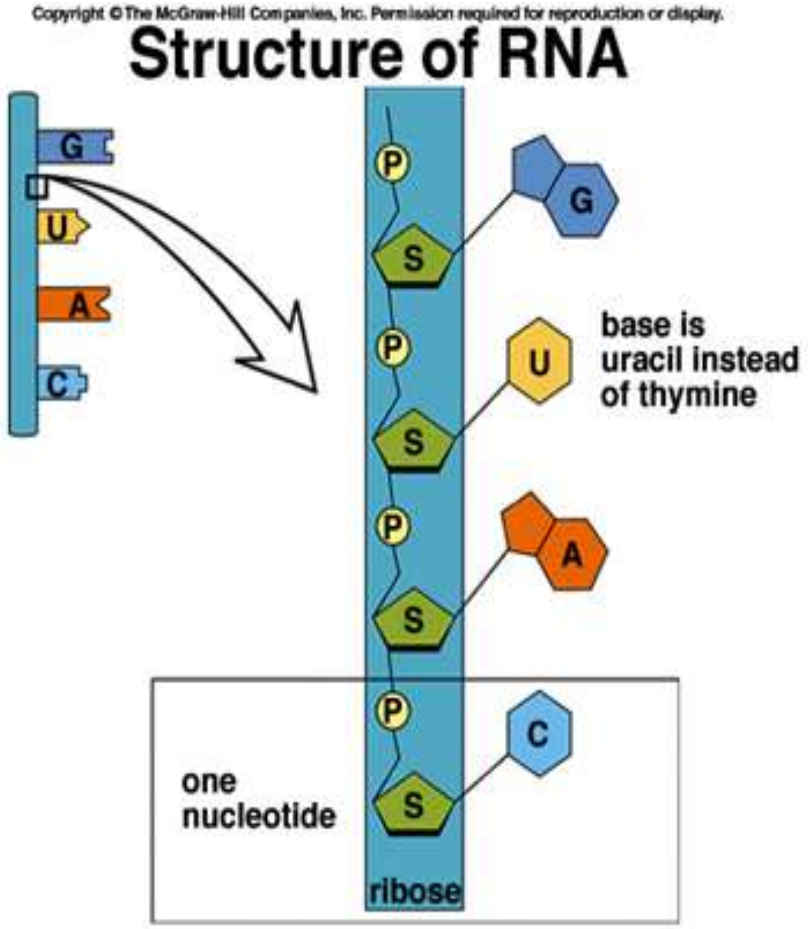
# What is DNA?

- Deoxyribonucleic Acid
- Genetic Information
- Stores and transmits all genetic information needed for the existence of living organisms
- Each cell in a multicellular organism has the same exact copy of DNA



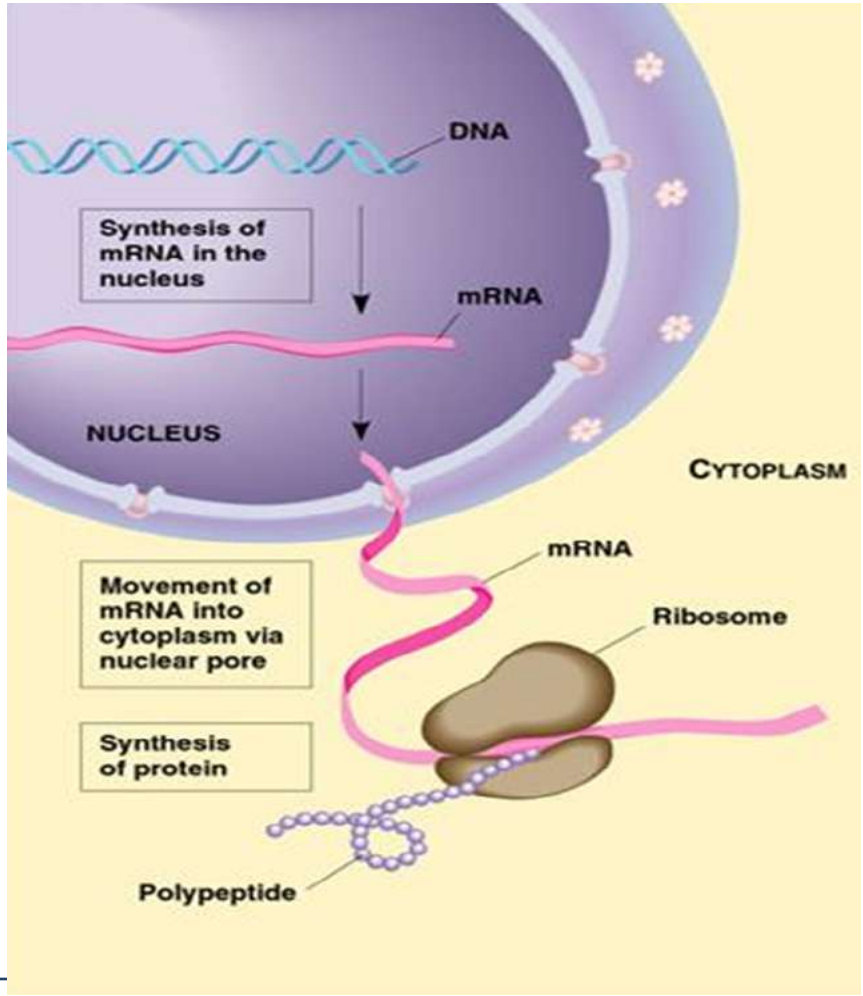
# What is RNA?

- Ribonucleic Acid
- Single strand
- Job – Read the DNA
- RNA carries out the work of DNA
  - DNA is the blueprint
  - RNA is the Contractor/Builders



# Types of RNA

- mRNA goes into the nucleus and gets the message from DNA
  - Codon
  - Single stranded
- rRNA reads (translates) the mRNA so the DNA command can be carried out
- tRNA gets the message from rRNA and obtains the necessary parts
  - Anticodon
  - Bring AA to Ribosomes for protein assembly

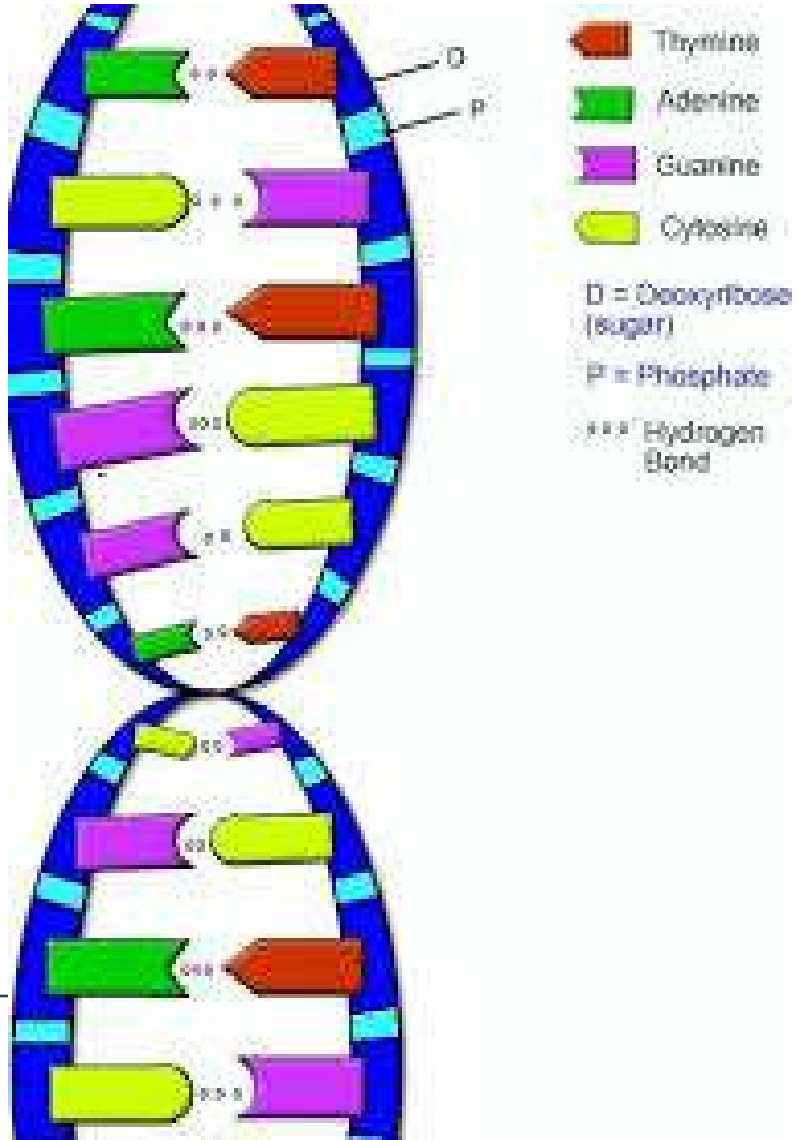


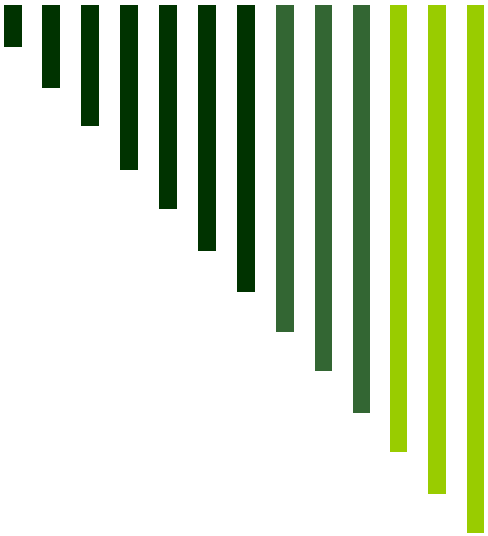
# Structure of Molecules

- DNA
  - Deoxyribose – 5 carbon sugar
  - Phosphate
  - Nitrogen base
- RNA
  - Ribose – 5 carbon sugar
  - Phosphate
  - Nitrogen Bases

# Complementary Base Pairing

- DNA has two sides or strands. We say that one strand is complementary to the other, meaning that they use Chargaff's base pairing rule to match up.
- Chargaff's rule states that:
  - Adenine always pairs with thymine (A-T) &
  - In RNA, adenine always pairs with uracil (A-U)
  - Cytosine always pairs with guanine (C-G)
- The two strands of DNA are held together by hydrogen bonds.





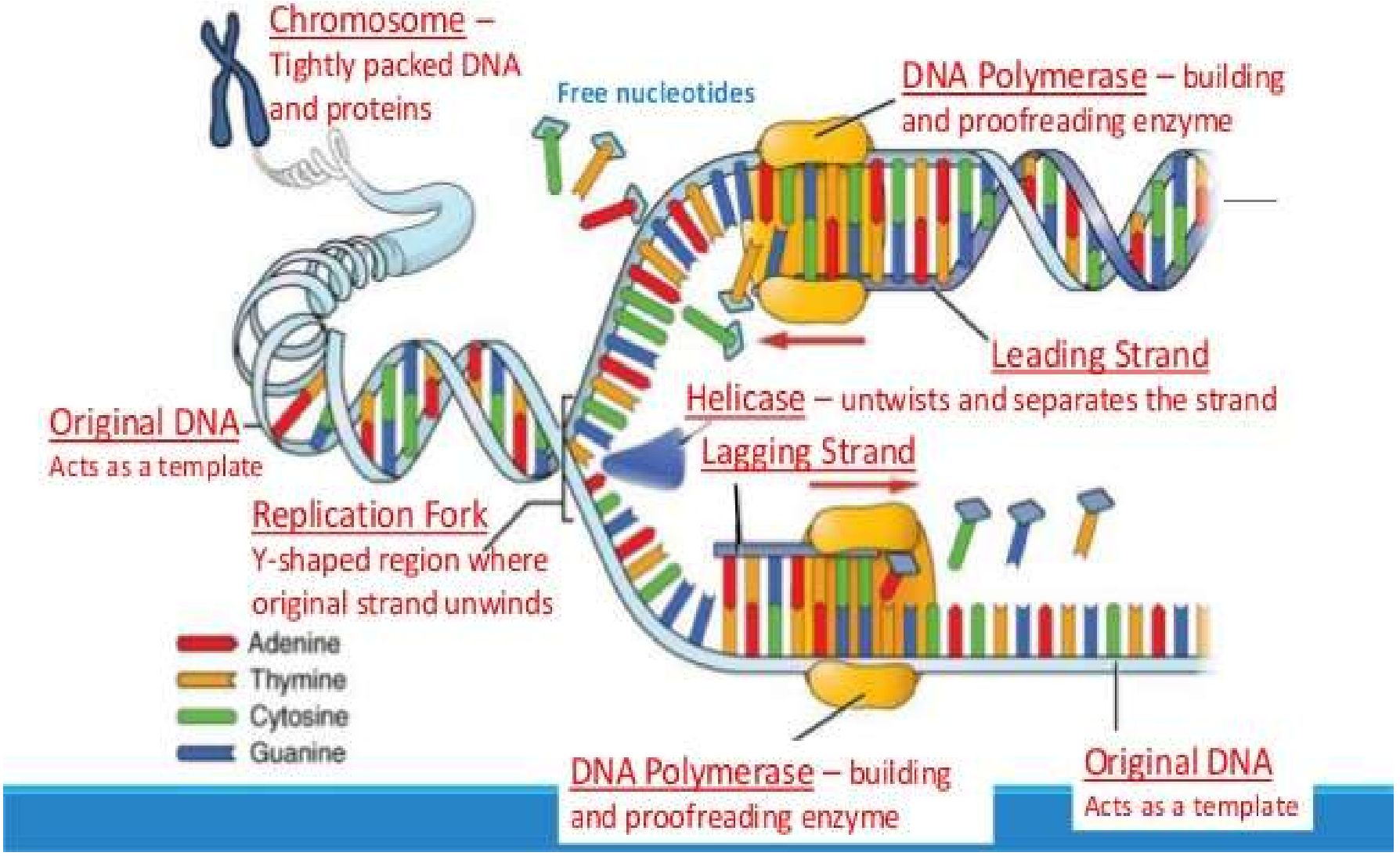
# REPLICATION

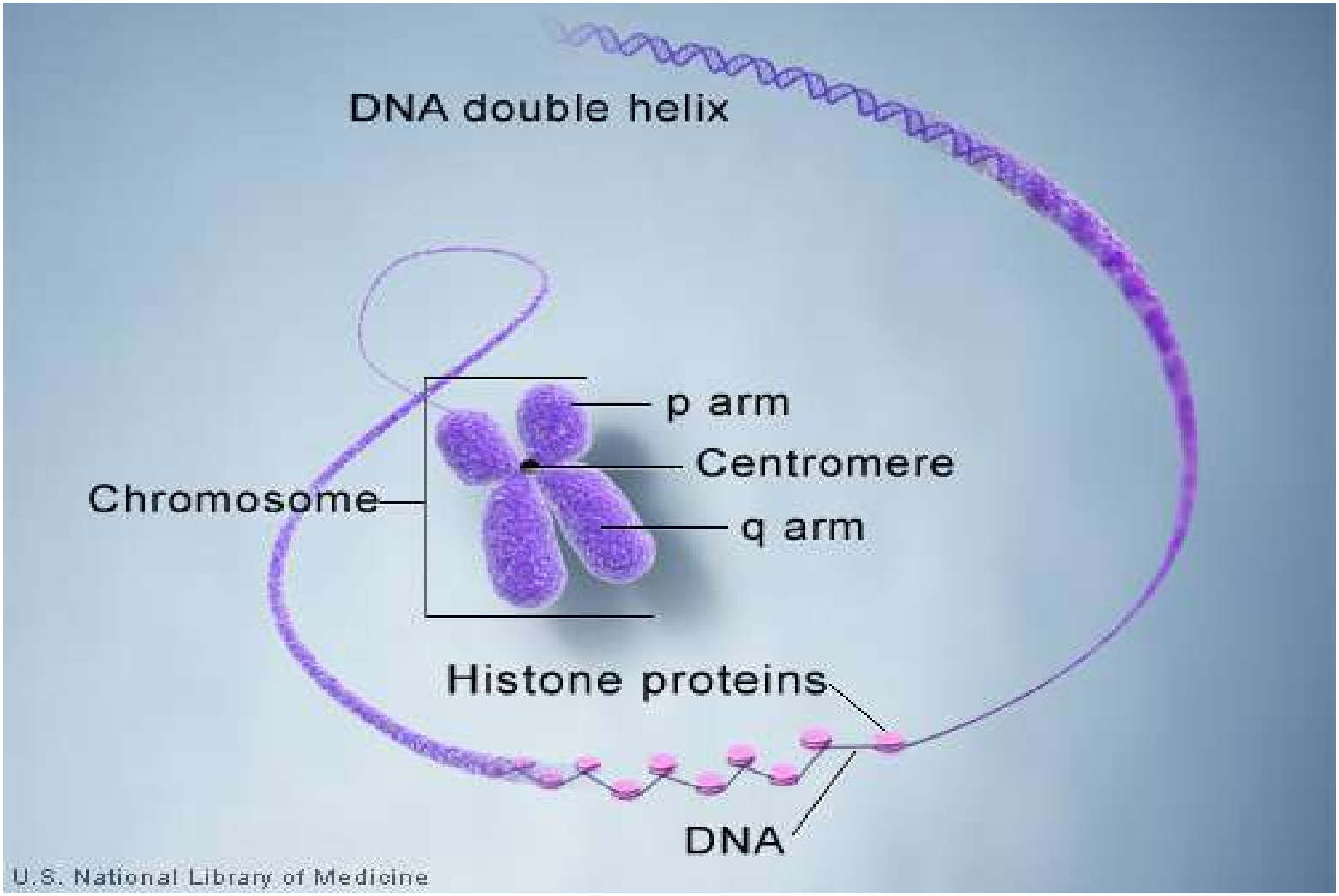
# Replication of DNA

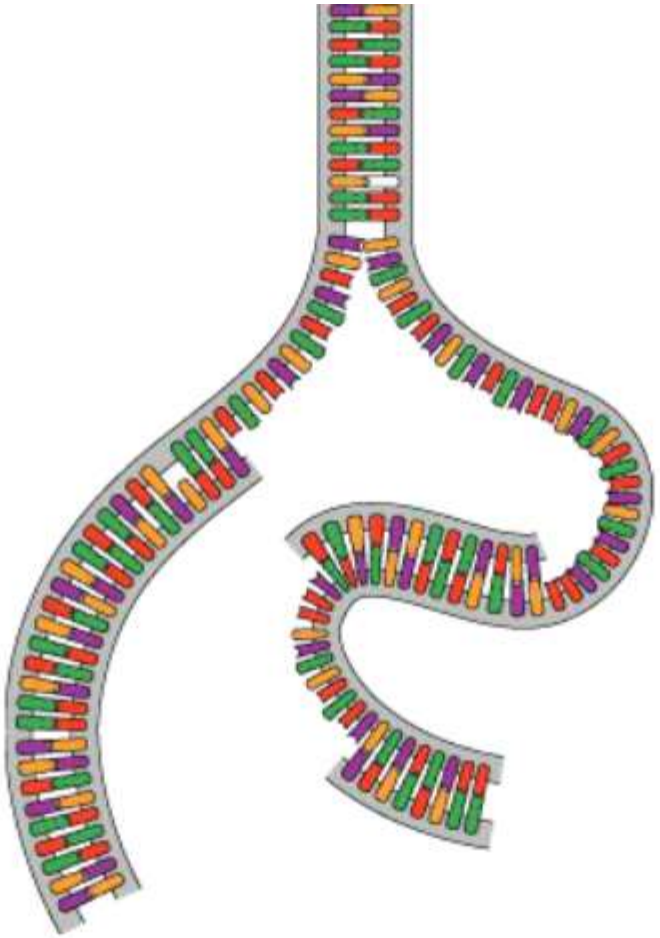
- DNA has to copy itself because when new cells are made, the cell has to have an exact copy of the DNA.
- This occurs during the cell cycle in the S phase.
- This process is called Replication
  - It is considered semiconservative

# Replication continued

- Replication begins with DNA untwisting itself and opening up
  - DNA Helicase
    - Responsible for unwinding the molecule
- The old DNA strands = templates
- New nucleotides come and bond to the template creating a new strand = Complementary Strand
  - DNA Polymerase
    - Responsible for adding nucleotides
    - Forms covalent bond between nucleotides
  - DNA ligase binds the two new strands


Chromosome –
Tightly packed DNA
and proteins
Free nucleotides
DNA Polymerase – building
and proofreading enzyme
Leading Strand
Helicase – untwists and separates the strand
Original DNA
Acts as a template
Lagging Strand
Replication Fork
Y-shaped region where
original strand unwinds
Adenine
Thymine
Cytosine
Guanine
DNA Polymerase – building
and proofreading enzyme
Original DNA
Acts as a template

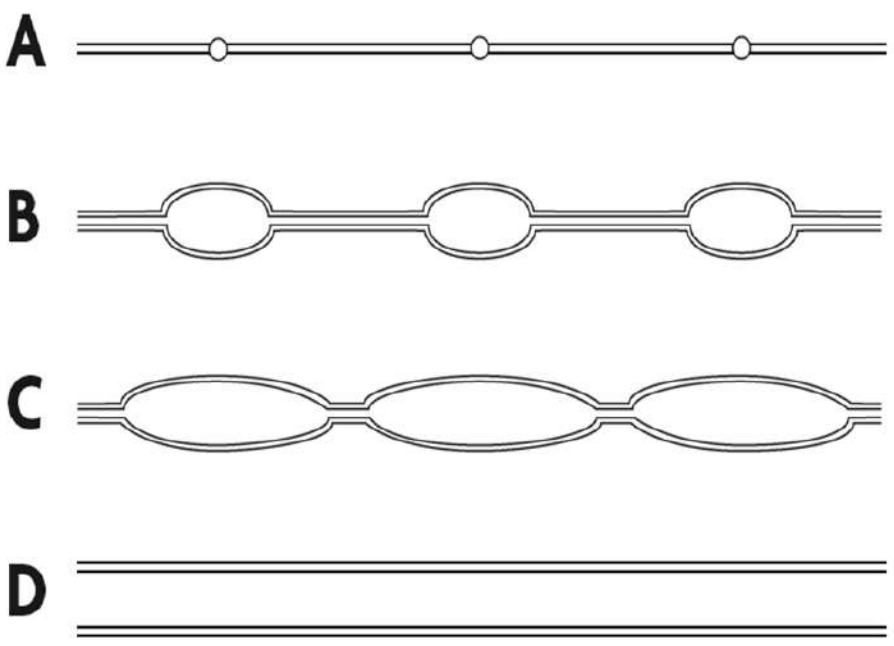

DNA double helix
p arm
Centromere
Chromosome
q arm
Histone proteins
DNA
U.S. National Library of Medicine



reset

# Replication continued

- DNA is read in parts
  - It does not start at the beginning and go all the way to the end, that would take too long
- Replication can start at many points in eukaryotes



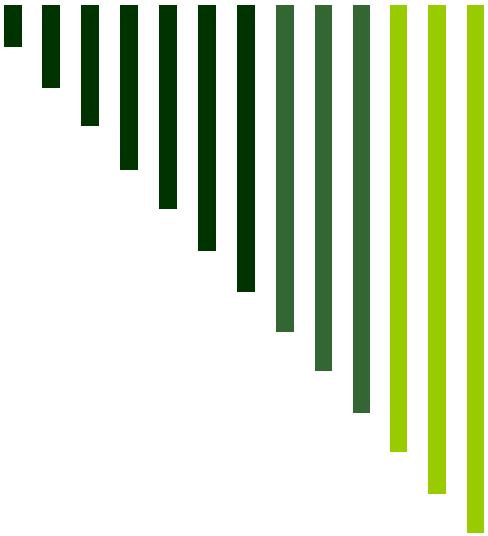

There are many origins of replication in eukaryotic chromosomes.

# Replication continued

- DNA is "proof read" by enzymes
  - The enzymes fix any mistakes
    - DNA polymerase
  - Mistakes not fixed will cause problems
    - We will discuss the problems when we get to human genetics

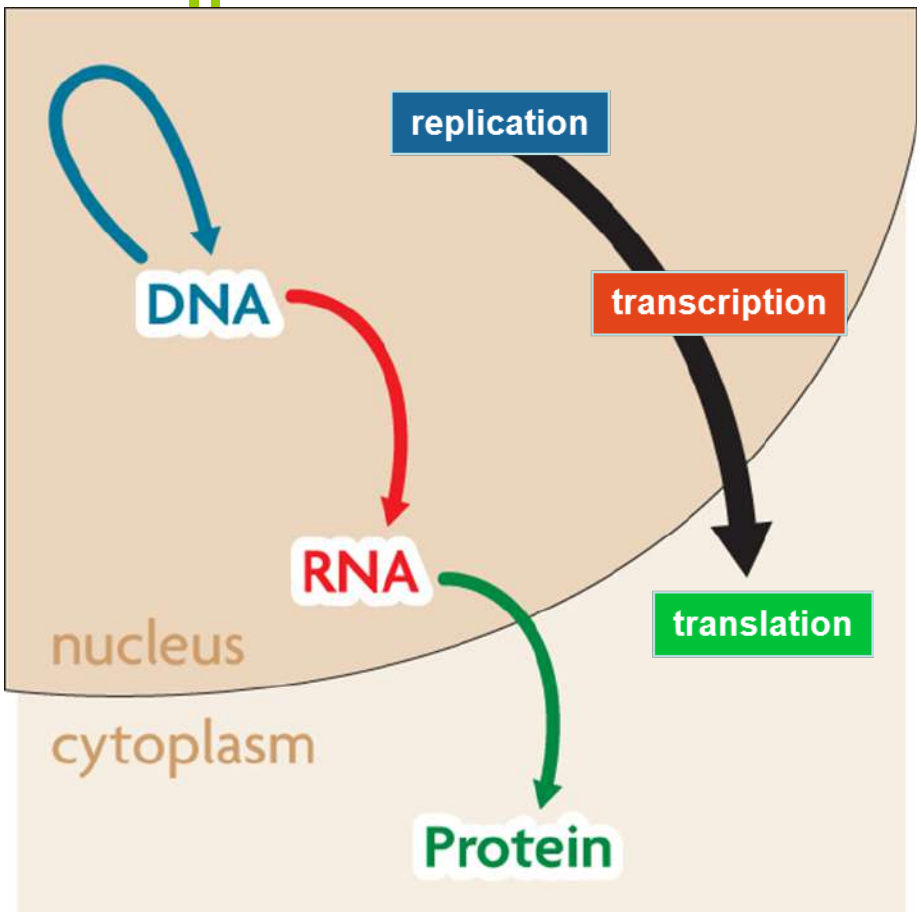
# Practice Replication

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

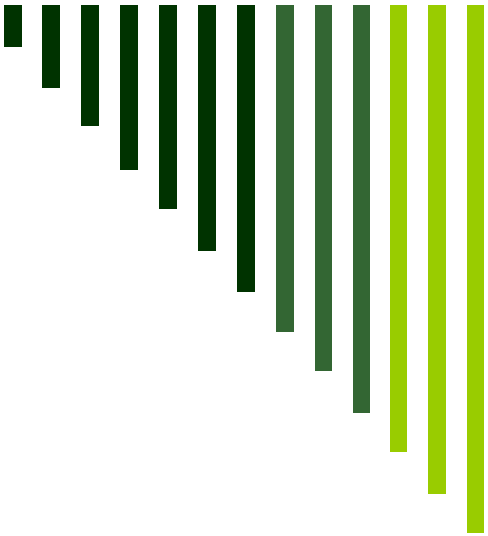


# Central Dogma

# Central Dogma




- The central dogma states that information flows in one direction from DNA to RNA to proteins.



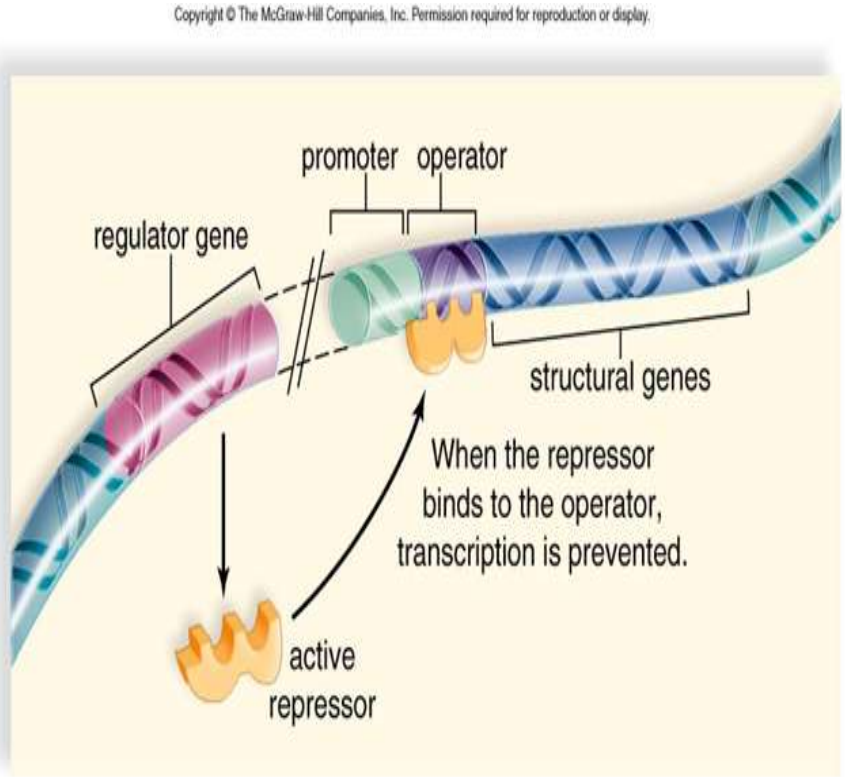
# TRANSCRIPTION

# Transcription

- Transcription is the process of mRNA copying DNA
  - This is how new mRNA is made
  - Copies a gene and can make many copies
- This occurs in the nucleus
- Occurs just like replication but with RNA instead
  - Only one side of the DNA is copied
  - Enzyme – RNA Polymerase

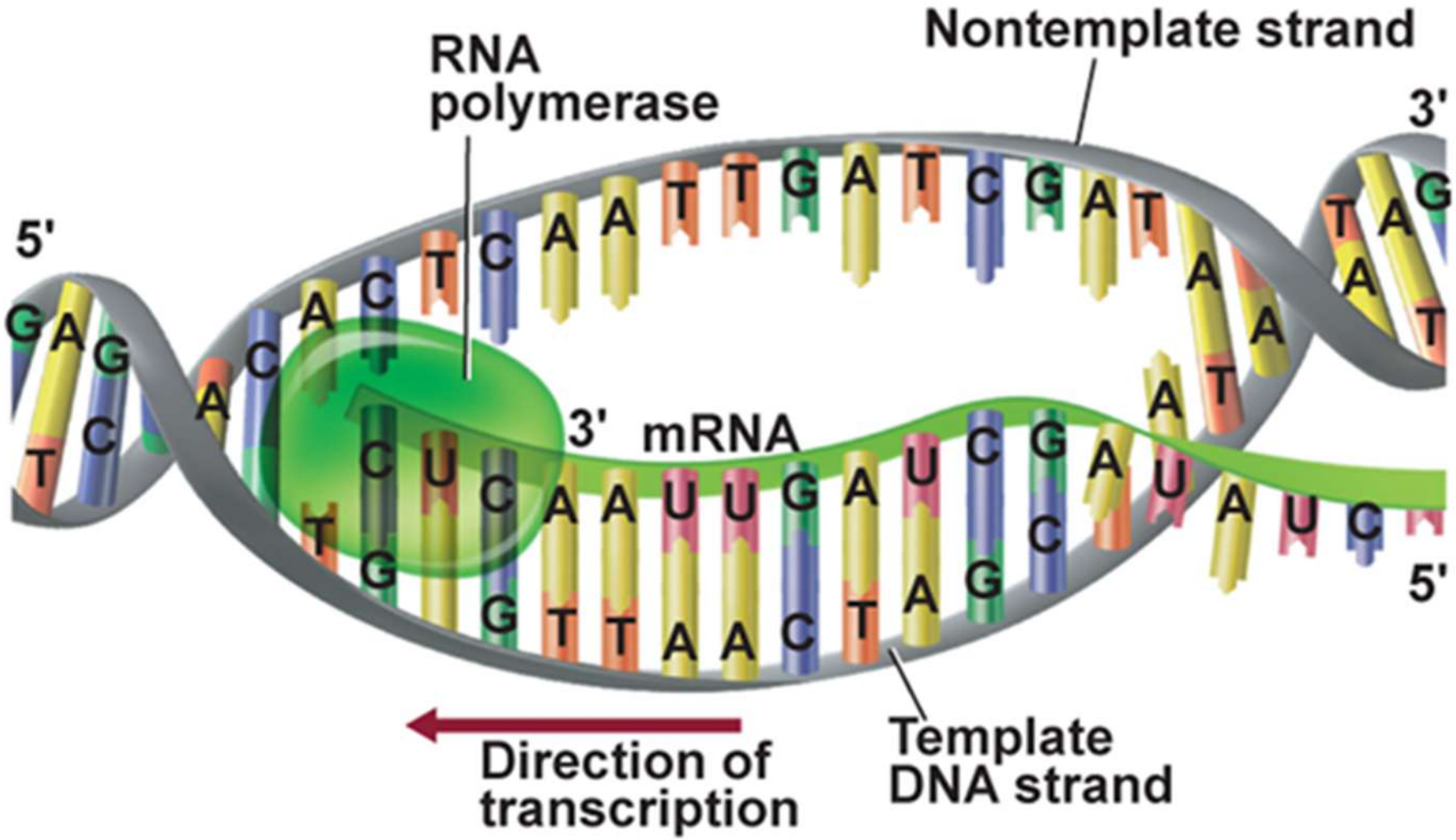
# Transcription

- Operon – the “switch” to turn on/off transcription
- Promoter – DNA site that promotes RNA polymerase to bind
- Repressor – molecule that binds to DNA to block transcription
- Inducer – molecule that takes repressor away

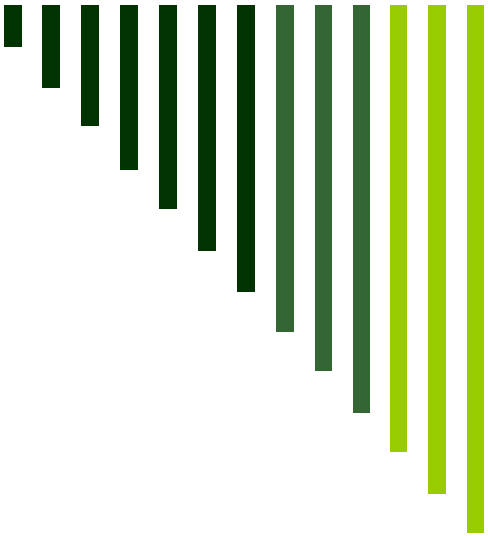


# Practice Transcription

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


RNA
polymerase
Nontemplate strand
3'
5'
3'
mRNA
5'
Direction of
transcription
Template
DNA strand

# Transcription



# TRANSLATION

# Translation

- a/k/a Protein Synthesis
- DNA is ultimately a code for protein production
- Proteins in turn make up all the parts of cells which will then control all chemical processes
- Proteins are made up of Amino Acids

# Translation

1. mRNA transcribes the DNA (gets the message/code)

2. mRNA carries the message from the nucleus to the ribosomes (on the ER)

3. rRNA inside the ribosomes reads the mRNA

# Translation continued

4. rRNA tells tRNA which Amino Acids are needed

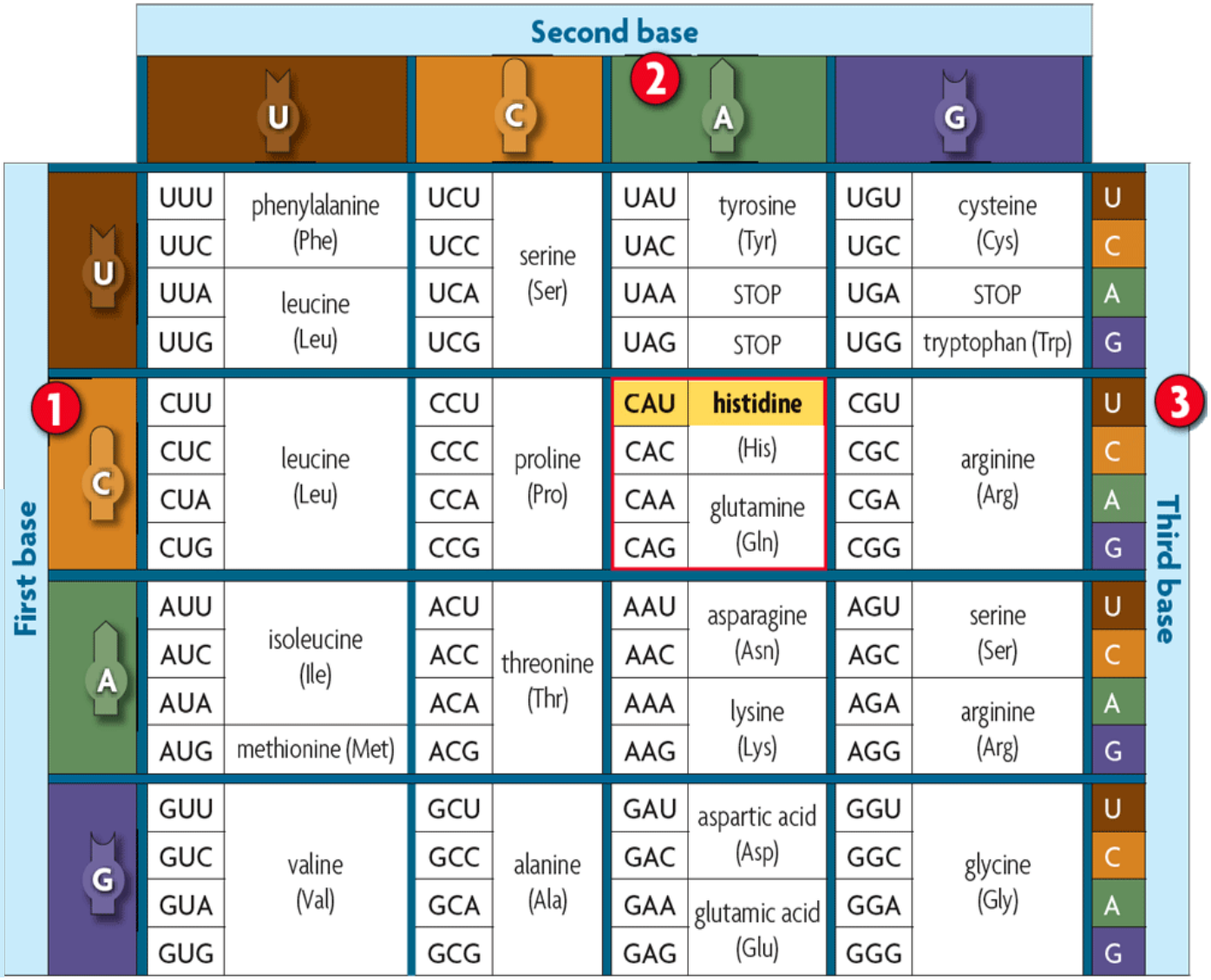
5. tRNA collects and brings back the Amino Acids

6. rRNA hooks together the Amino Acids into a protein

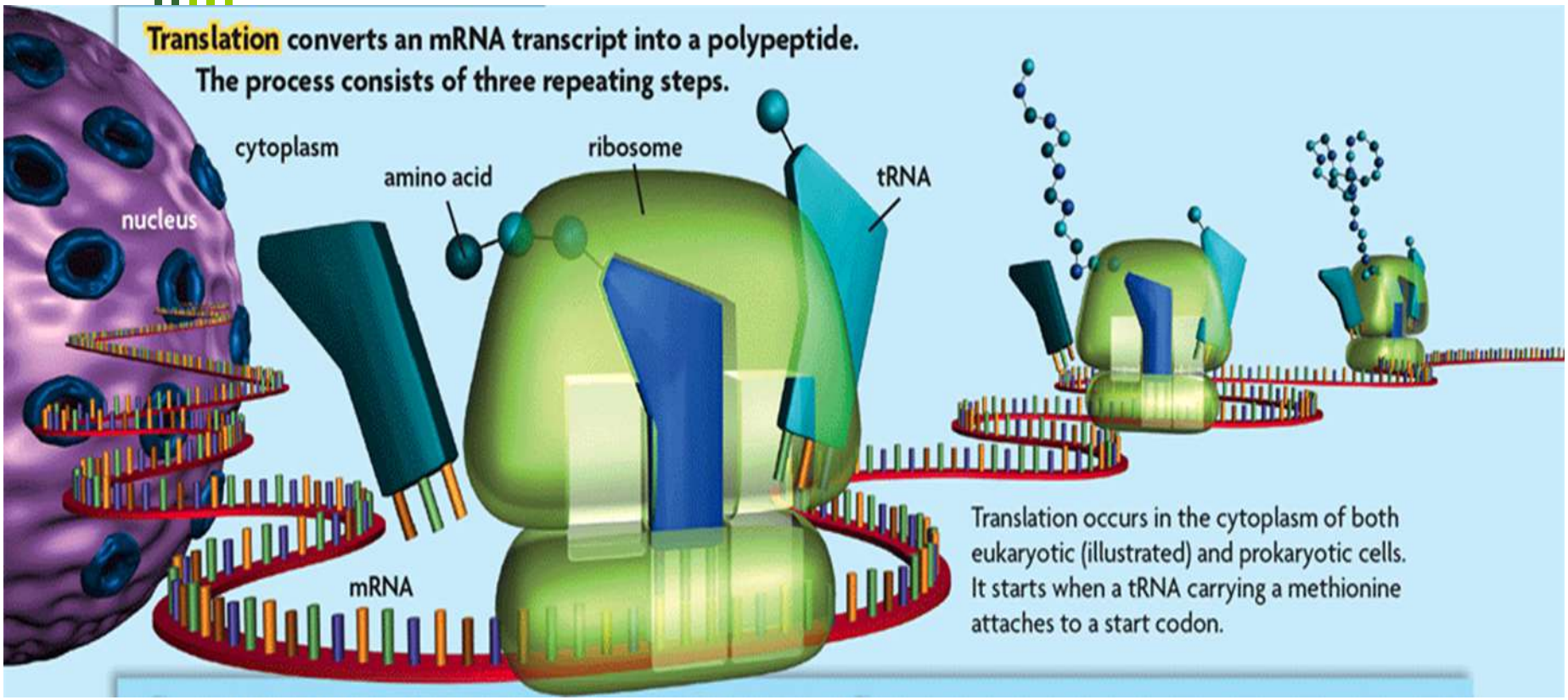
# Codons

- Every 3 nitrogen bases on the mRNA = Codon
  - A codon is a code for an Amino Acid or start and stop codons.
    - Start Codon: AUG (needed for process to begin)
    - Stop Codons: UAA, UGA, UAG
- On the tRNA is an anticodon – it is complementary to the codon
- Example: Codon UUU, Anticodon AAA
- Practice: Codon CGC, Anticodon

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

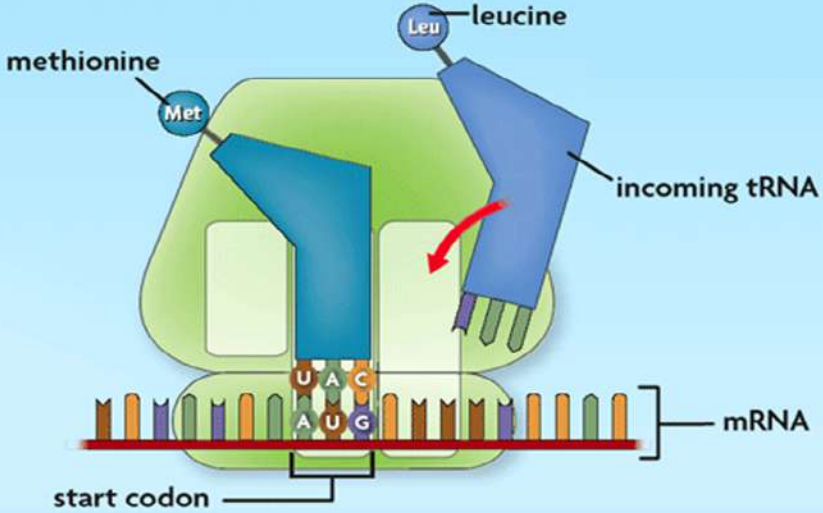



1. Find the first base, C, in the left column.
2. Find the second base, A, in the top row. Find the box where these two intersect.
3. Find the third base, U, in the right column. CAU codes for histidine, abbreviated as His.


Translation converts an mRNA transcript into a polypeptide.
The process consists of three repeating steps.
cytoplasm
amino acid
ribosome
tRNA
nucleus
mRNA
Translation occurs in the cytoplasm of both eukaryotic (illustrated) and prokaryotic cells. It starts when a tRNA carrying a methionine attaches to a start codon.

1

The exposed codon in the first site attracts a complementary tRNA bearing an amino acid. The tRNA anticodon pairs with the mRNA codon, bringing it very close to the other tRNA molecule.

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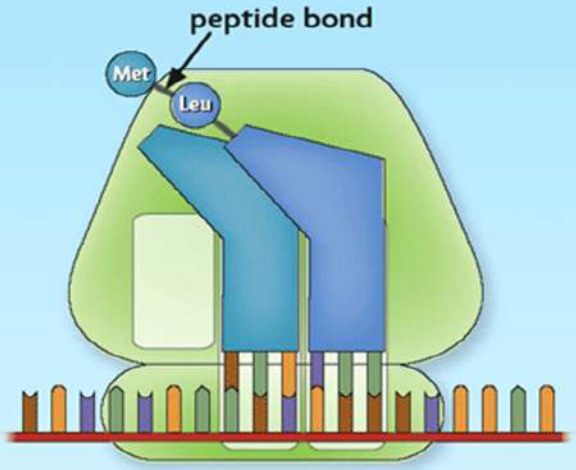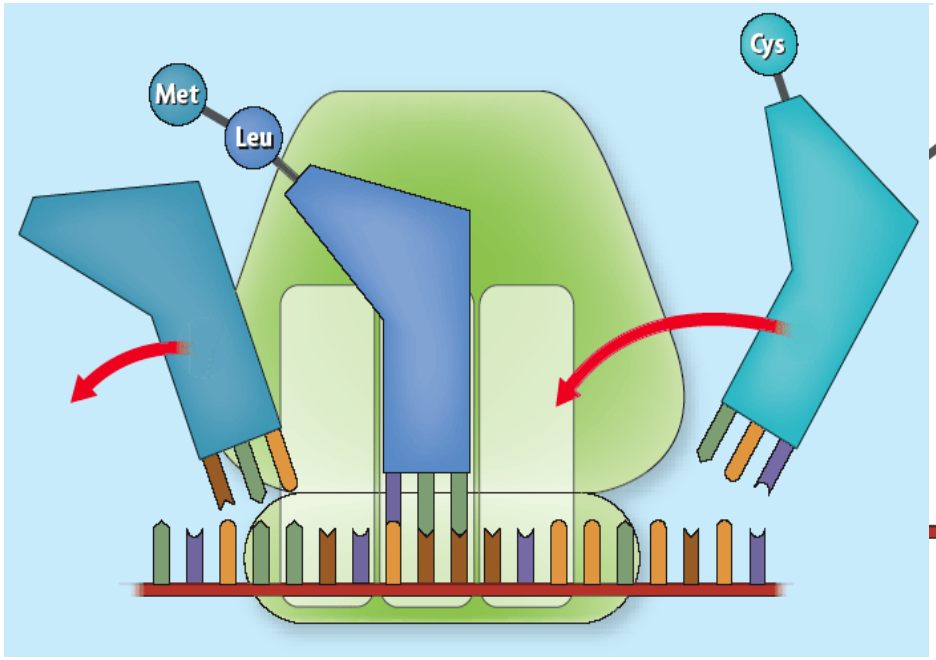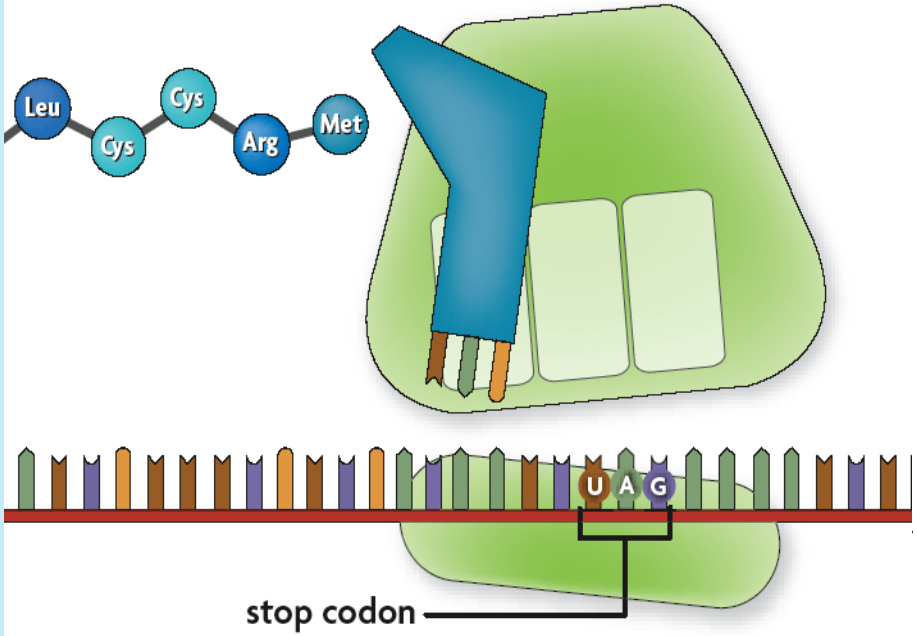
The ribosome forms a peptide bond between the two amino acids and breaks the bond between the first tRNA and its amino acid.