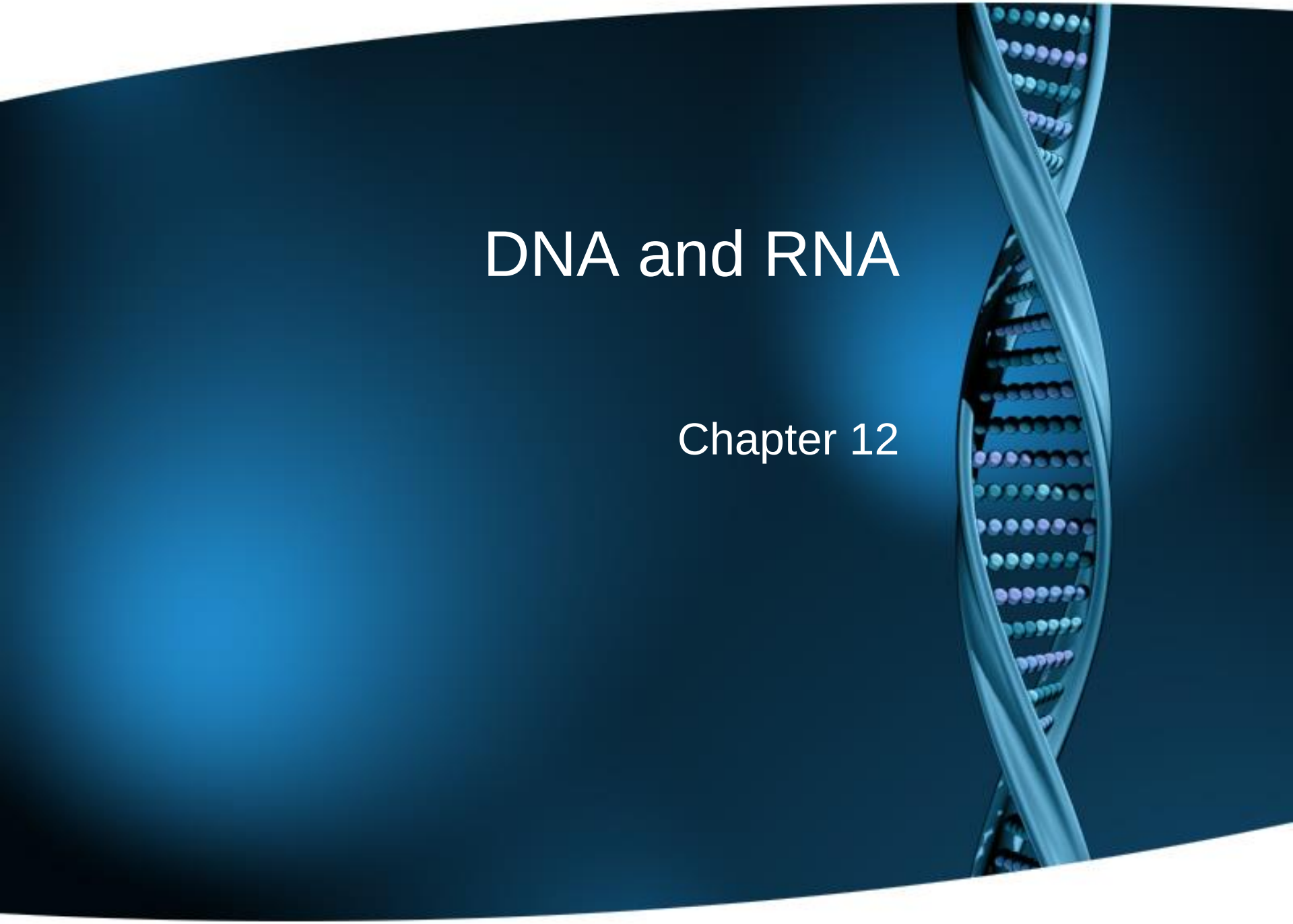
DNA and RNA

Chapter 12

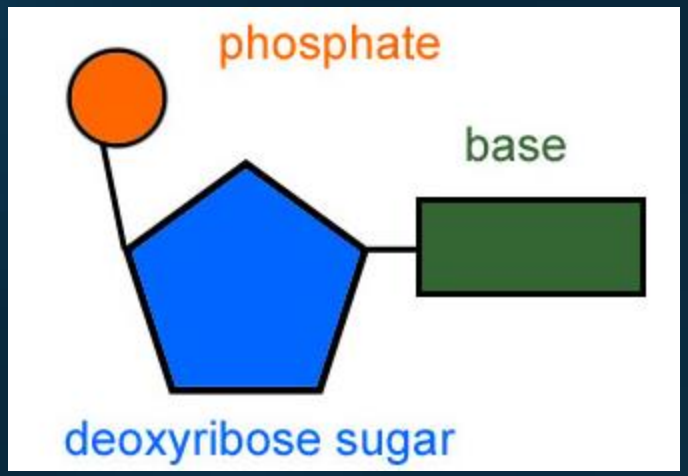


Warm Up Exercise

- Test Corrections
  - Make sure to indicate your new answer and provide an explanation for why this is the correct answer. Do this with a red pen in the margins of your original test paper.

The Components and Structure of DNA

- DNA is made up of units called nucleotides.
- Nucleotides are made up of three basic components:
  - A 5-carbon sugar, called deoxyribose in DNA
  - A phosphate group
  - A nitrogen base

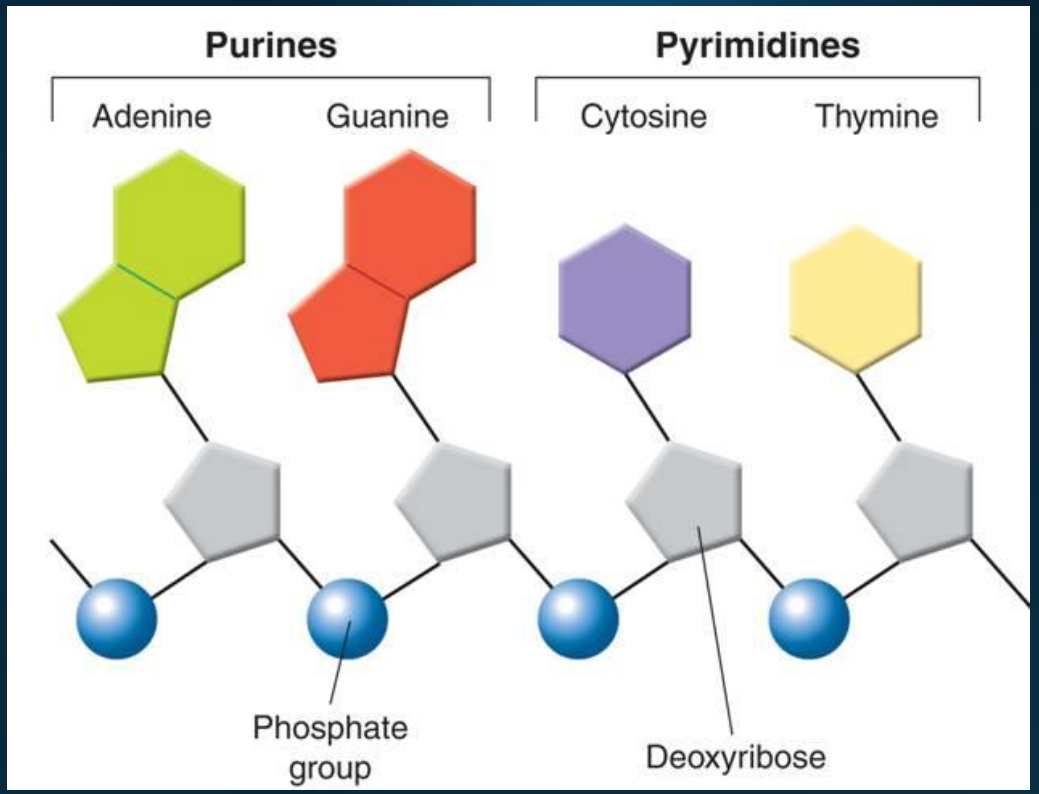


The Components and Structure of DNA

- There are 4 types of nitrogen bases
  - Adenine
  - Thymine
  - Guanine
  - Cytosine

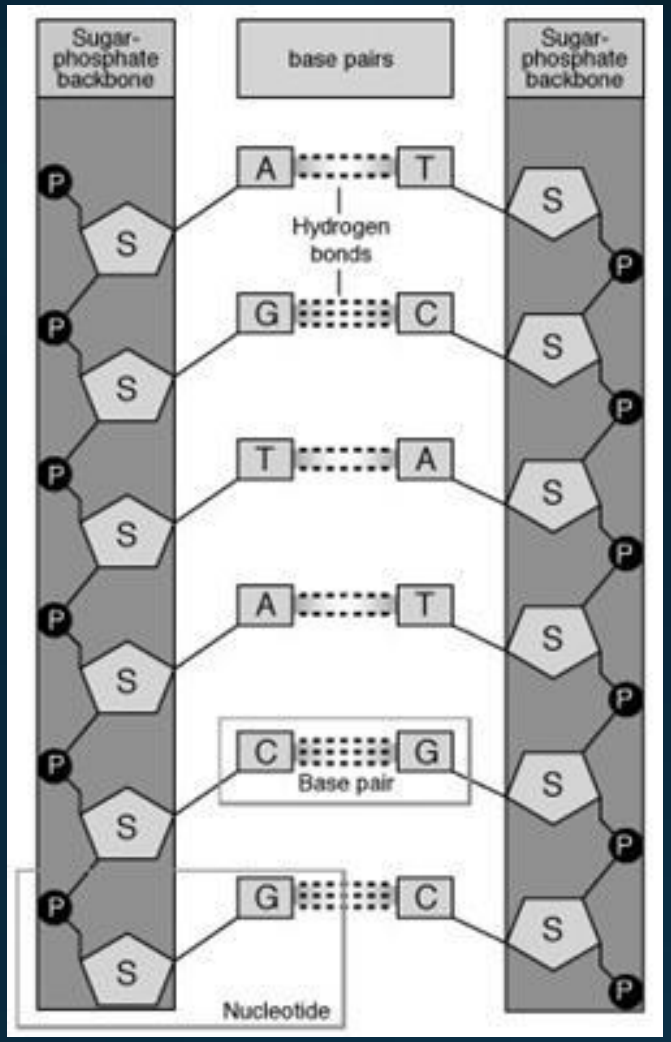
Purines = 2 rings

Pyrimidines = 1 ring



The Components and Structure of DNA

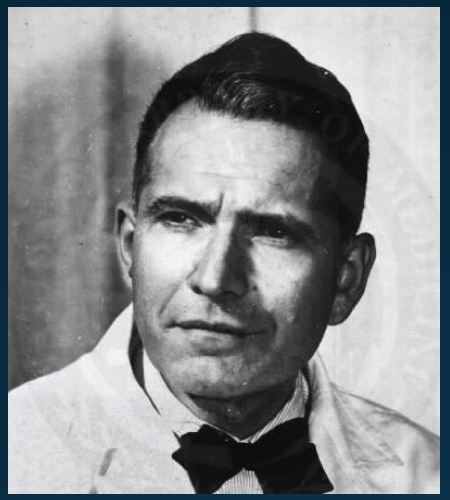
- The backbone of a DNA chain is formed by sugar and phosphate groups of each nucleotide.
- The nucleotides can be joined together in any order.



The Components and Structure of DNA

Chargaff's Rules

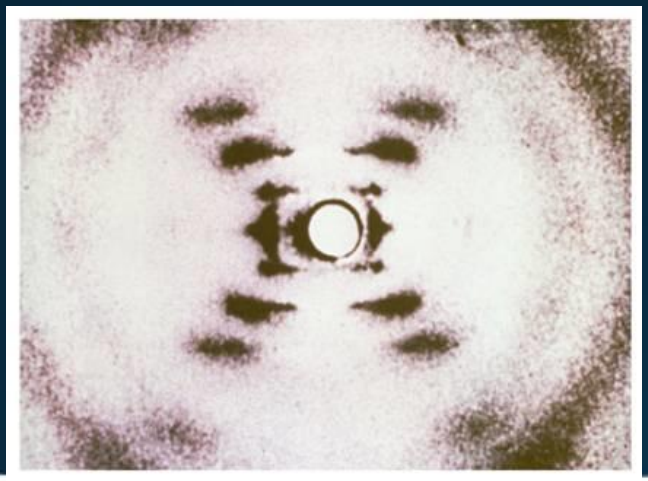
- Erwin Chargaff discovered that
  - The percentages of guanine (G) and cytosine (C) bases are almost equal in any sample of DNA.
  - The percentages of adenine (A) and thymine (T) bases are almost equal in any sample of DNA.
- *Thus, A pairs with T and G pairs with C*.



The Components and Structure of DNA

X-Ray Evidence

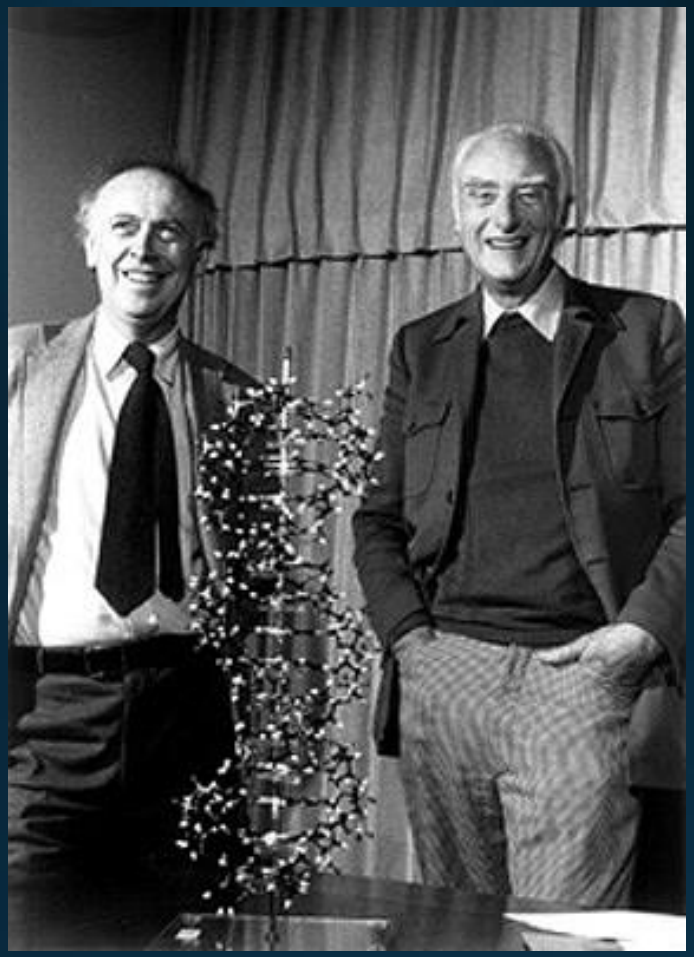
- Rosalind Franklin used X-ray diffraction to obtain information about the structure of DNA.



The Components and Structure of DNA

The Double Helix

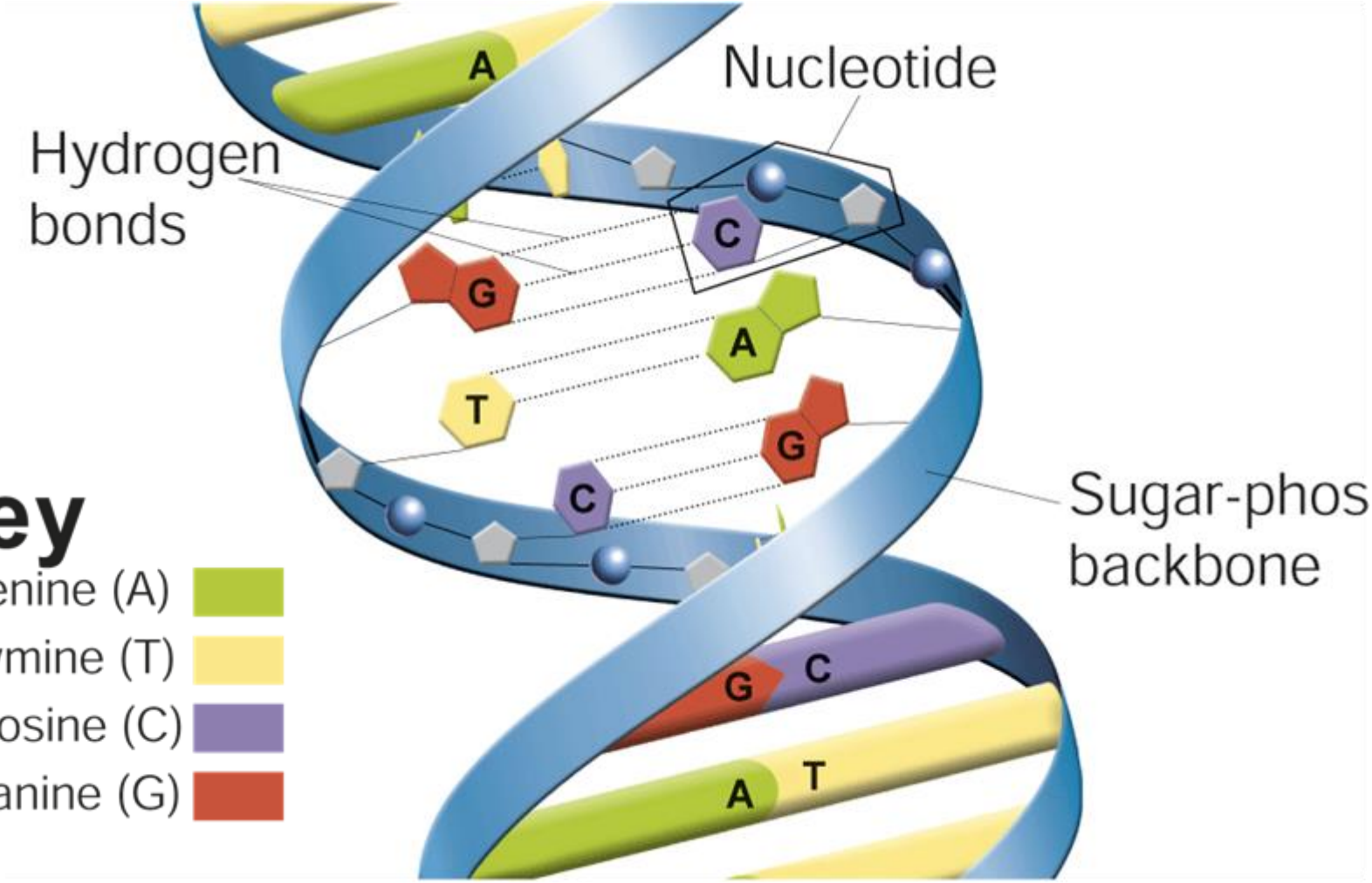
- Using clues from Franklin's pattern, James Watson and Francis Crick built a model that explained how DNA carried information and how it could be copied.



The Components and Structure of DNA

- Watson and Crick's model of DNA was a double helix, in which two strands were wound around each other, like a twisted ladder or spiral staircase.
- They discovered that hydrogen bonds formed between specific nitrogenous bases and hold the two strands together.
  - This principle is called base pairing, and explained Chargaff's rules.

The Structure of DNA



Quick Assess- Post It Style

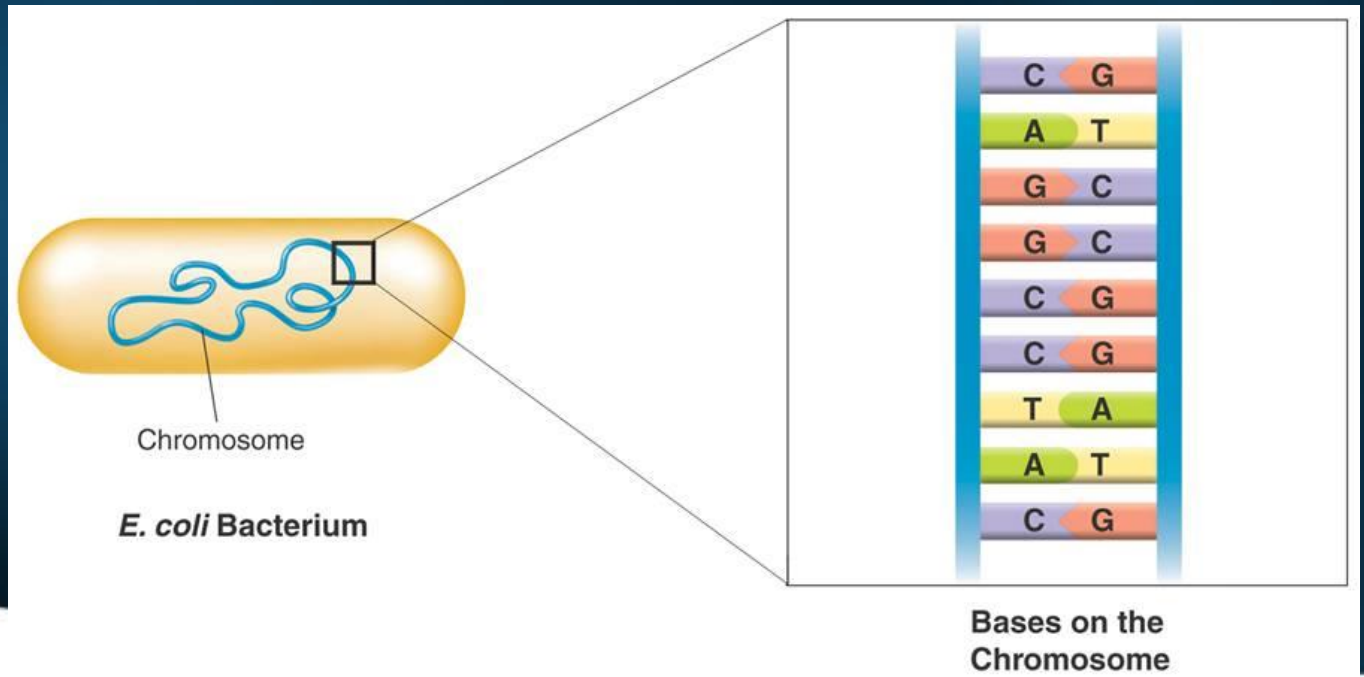
- What are the four kinds of bases found in DNA and how do the bases pair?

Warm Up Exercise

- What are the three parts of a nucleotide?
- What makes up the backbone of DNA?
- Whose rules state that A pairs with T and G pairs with C?
- Who got the credit for the structure of the DNA molecule?

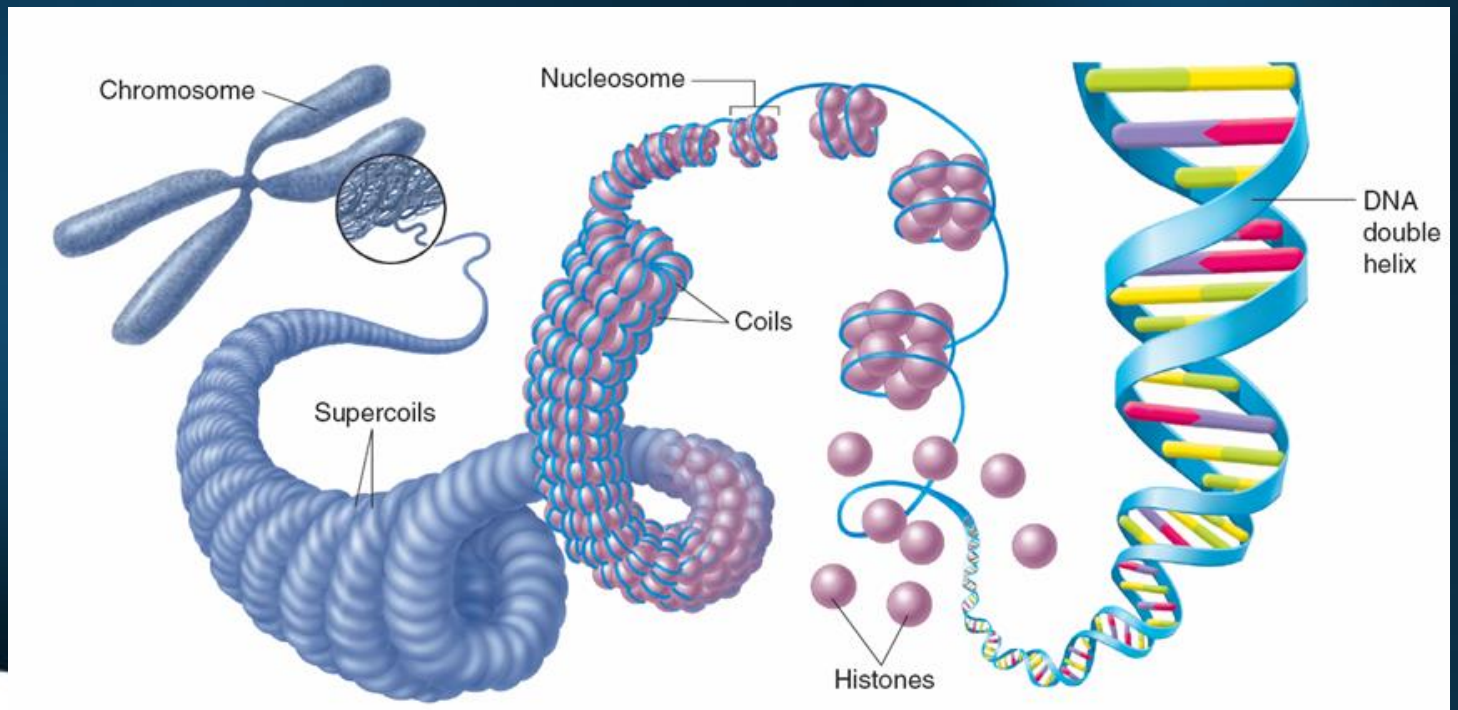
Prokaryotic DNA

- Most prokaryotes have a single circular DNA molecule found in the cell's cytoplasm. This large DNA molecule is typically referred to as the cell's chromosome.



Eukaryotic DNA

- Eukaryotic DNA is located in the nucleus in the form of chromosomes.
- DNA molecules are very long. The nucleus of a human cell contains more than 1 meter of DNA.



Chromosome Structure

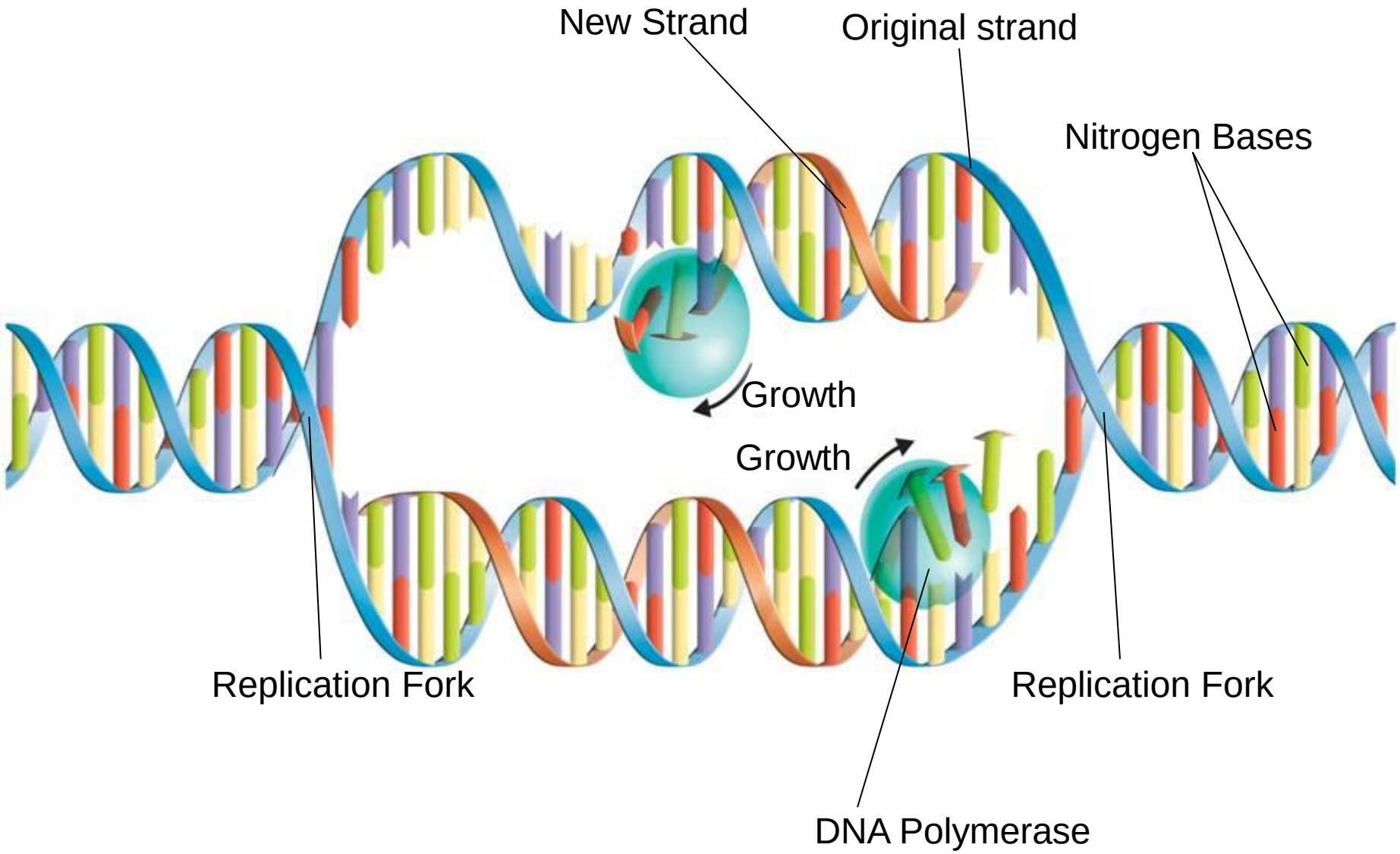
- Eukaryotic chromosomes contain both DNA and protein packed together to form a substance called chromatin.
- Chromatin consists of DNA that is tightly coiled around proteins called histones.
- Together, the DNA and the histone form a beadlike structure called a nucleosome.
- Nucleosomes pack together to form a thick fiber which coils up. Nucleosomes fold huge lengths of DNA into the tiny space available in the cell nucleus.

DNA Replication

- Before a cell divides, it duplicates its DNA in a copying process called DNA Replication.
  - This process ensures that each resulting daughter cell will have a complete set of DNA molecules.
- During DNA replication, the DNA molecule separates into two strands, and then produces two new complete sets of DNA.
  - Each strand of the double helix of DNA serves as a template or model for the new strand.

DNA Replication

- Replication proceeds in both directions until each chromosome is completely copied. The sites where separation and replication occur are called replication forks.


New Strand
Original strand
Nitrogen Bases
Growth
Growth
Replication Fork
Replication Fork
DNA Polymerase

Enzymes

- **DNA Helicase**- unzips the DNA molecule by breaking the hydrogen bonds.
- **DNA Polymerase**- joins individual nucleotides to produce a DNA molecule, which is a polymer. DNA polymerase also “proofreads” each new DNA strand, helping to eliminate replication errors.

Exit Slip

- Make a Venn diagram that compares the process of DNA replication in prokaryotes and eukaryotes. Compare the location, steps, and end products of the process in each kind of cell.

Advanced Warm Up Exercise

- Chapter 7 Standardized Test Prep

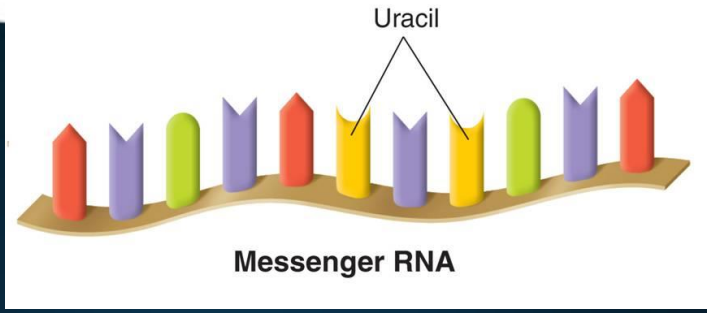
General Warm Up Exercise

- During DNA replication, the DNA molecule _____ (separates/combines) into 2 strands.
- At the end of DNA replication, _____ (four/two) new strands of DNA have been produced, giving a total of _____ (four/six) strands of DNA.
- New DNA is replicated in strands complementary to old DNA because production of new DNA follows the rules of _____ (base pairing/the double helix)

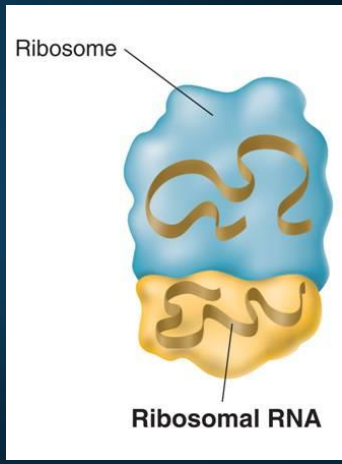
RNA and Protein Synthesis

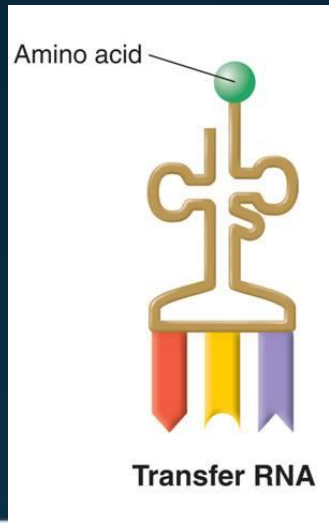
- **Genes**- coded DNA instructions that control the production of proteins within the cell.
  - In order to decode genes, the nucleotide sequence must be copied from DNA to RNA, as RNA contains the instructions for making proteins.
- 3 main differences between RNA and DNA:
  - The sugar in RNA is ribose instead of deoxyribose.
  - RNA is generally single-stranded.
  - RNA contains uracil in place of thymine.
- The main job of RNA is to assemble amino acids into proteins!

Types of RNA



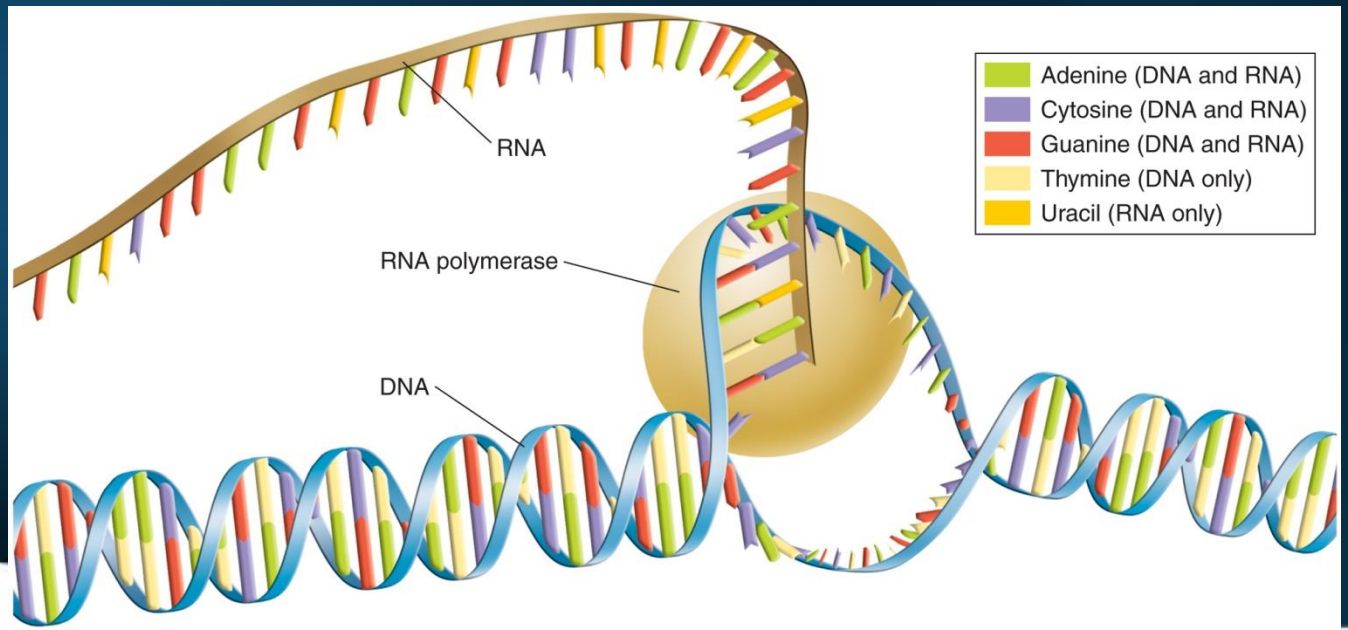
- **Messenger RNA (mRNA)**- serve as messengers from the DNA to the rest of the cell. They carry the instructions for assembling proteins into amino acids.
- **Ribosomal RNA (rRNA)**- help with protein assembly, which occurs on the ribosomes.
- **Transfer RNA (tRNA)**- transfers each amino acid to the ribosome as it specified by the coded messages in mRNA.





Transcription

- **<u>Transcription</u>**- RNA molecules are produced by copying part of the nucleotide sequence of DNA into a complementary sequence in RNA.
  - Requires <u>RNA polymerase</u>, which uses one strand of DNA as a template for the construction of the new strand of RNA.

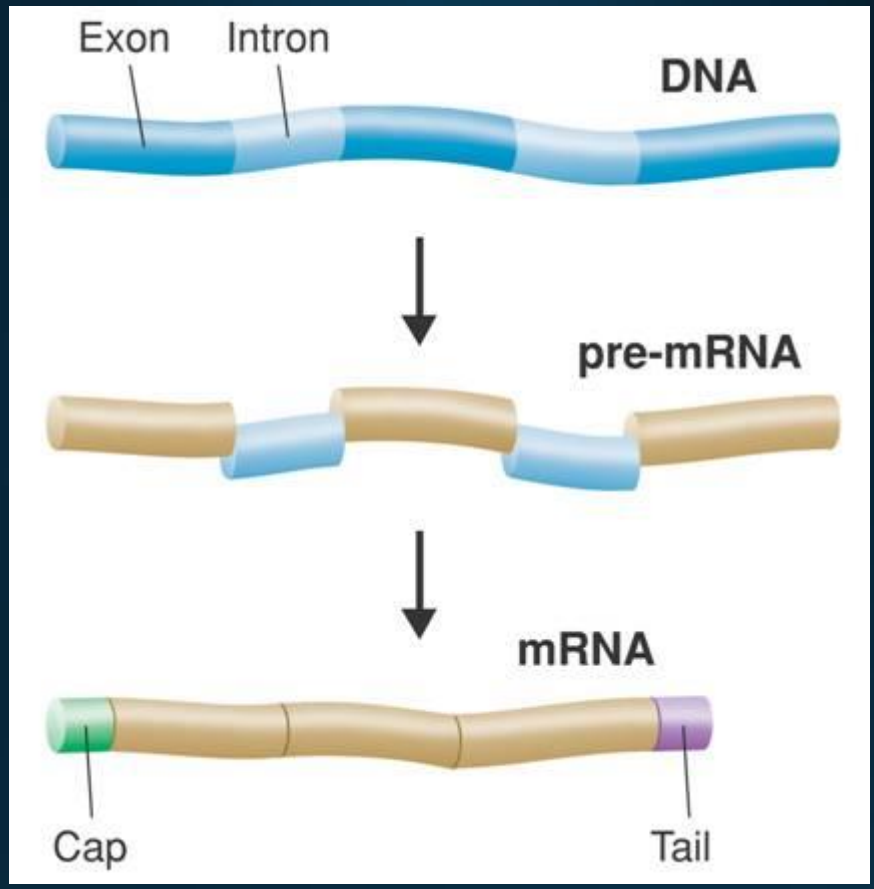


Transcription

- **Promoters**- specific region of DNA where RNA polymerase will bind. These regions have specific base sequences.

RNA Editing

- **Introns**- DNA nucleotide sequences that are not involved in coding for proteins.
- **Exons**- sequences that do code for proteins- they are "expressed" in the synthesis of proteins.



The Genetic Code

- **Codon**- consists of three consecutive nitrogen bases that specify a single amino acid that is to be added to the polypeptide.

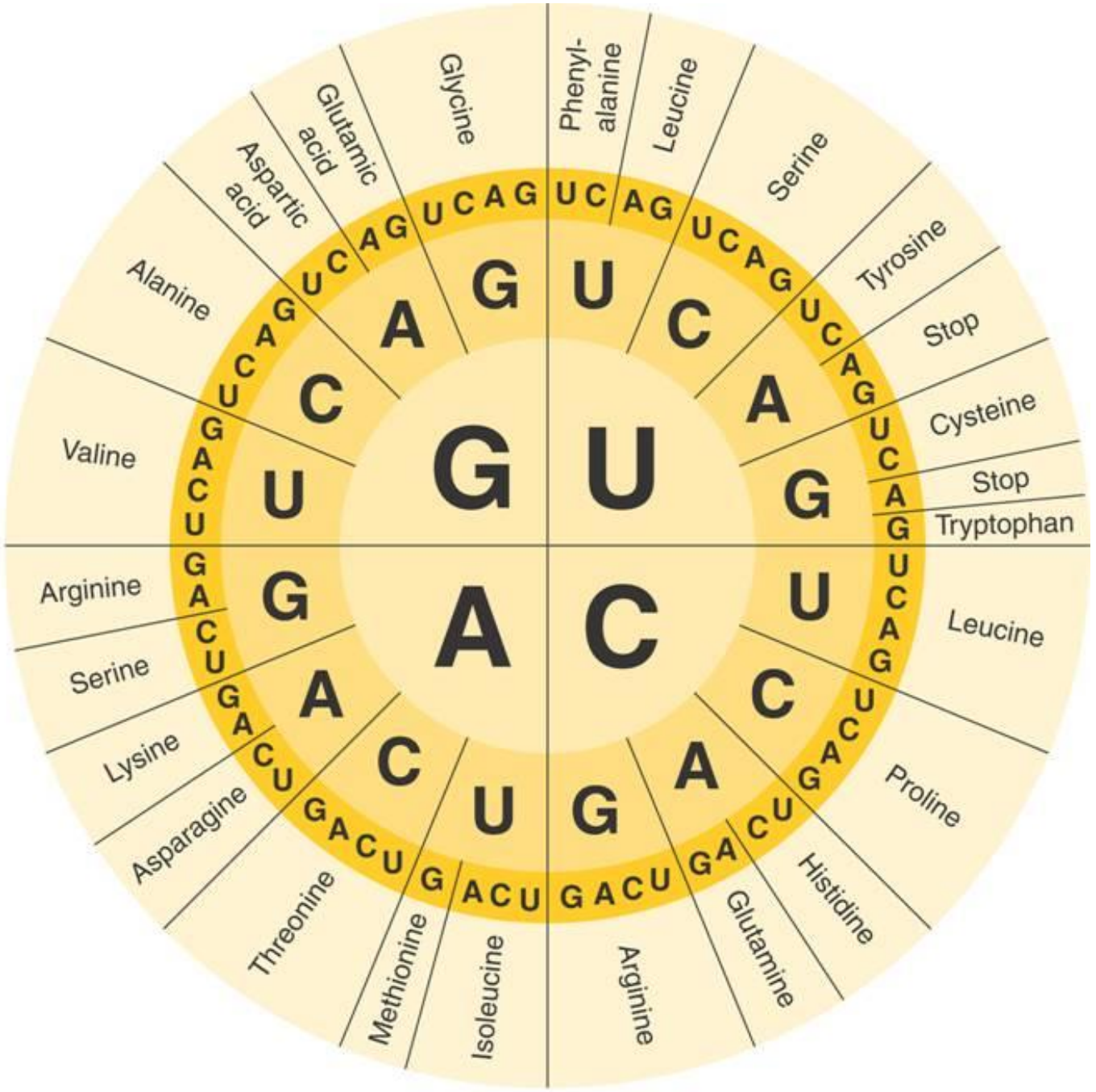
UCGCACGGU

This sequence would be read three bases at a time as:

UCG-CAC-GGU

The codons represent the different amino acids:

UCG = Serine, CAC = Histidine, GGU = Glycine

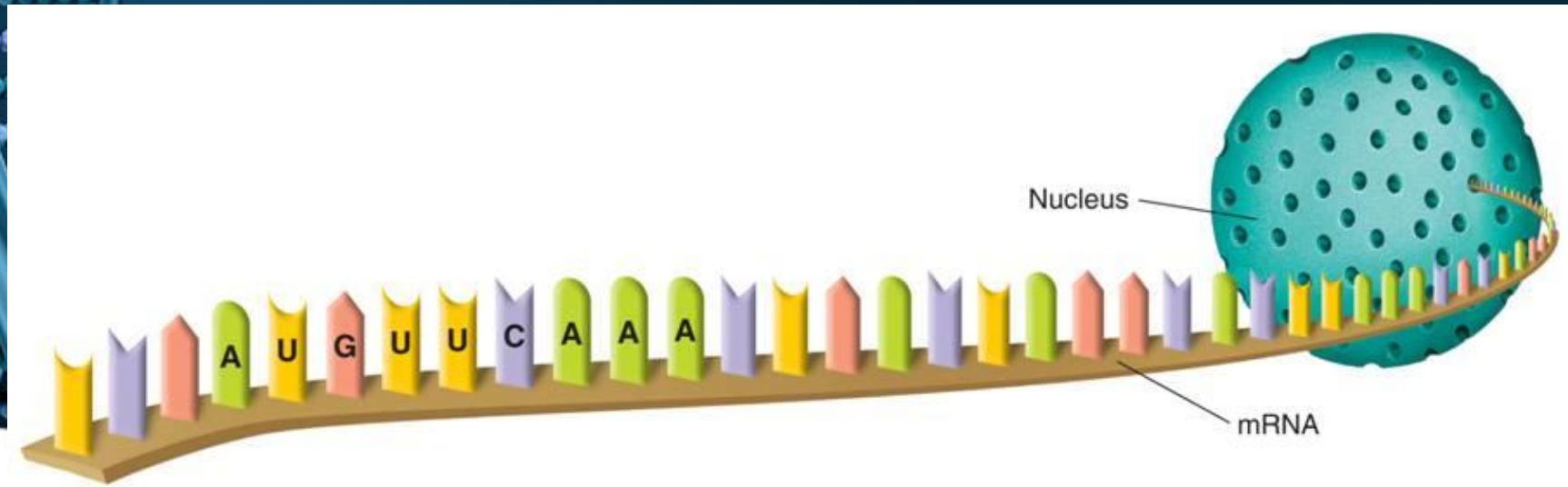

G
U
A
C
Phenyl-alanine
Leucine
Serine
Tyrosine
Stop
Cysteine
Stop
Tryptophan
Leucine
Proline
Histidine
Glutamine
Arginine
Isoleucine
Methionine
Threonine
Asparagine
Lysine
Serine
Arginine
Valine
Alanine
Aspartic acid
Glutamic acid
Glycine

The Genetic Code

- Because there are four different bases, there are 64 possible three-base codons (4x4x4 = 64).
- There is one codon, AUG, also known as methionine, which serves as the “start” codon for protein synthesis.
- There are three “stop” codons that do not code for any amino acids. They signal the end of a polypeptide.

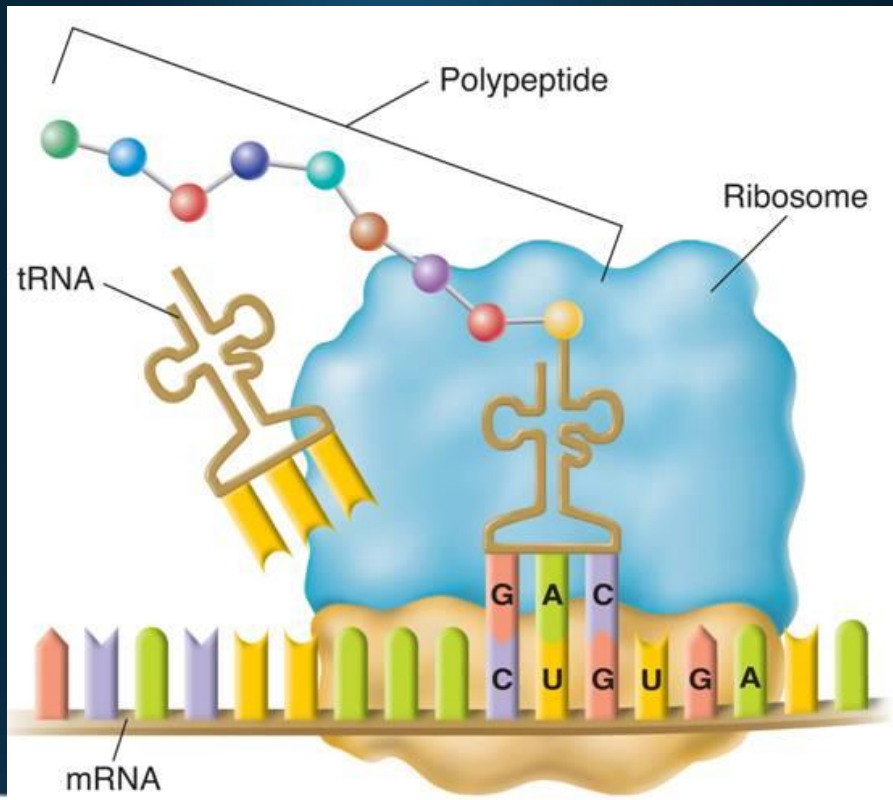
Translation

- **<u>Translation</u>**- decoding of an mRNA message to produce a protein.
  - Translation takes place on the ribosomes.
  - Before translation occurs, mRNA is transcribed from DNA in the nucleus and released into the cytoplasm.



Translation

- The rRNA joins the newly synthesized amino acids and breaks the bond between the amino acid and its tRNA. The tRNA floats away from the ribosome, allowing the rRNA to bind another tRNA.
- The ribosome moves along the mRNA binding new tRNA molecules and amino acids until it reaches a stop codon.



Translation

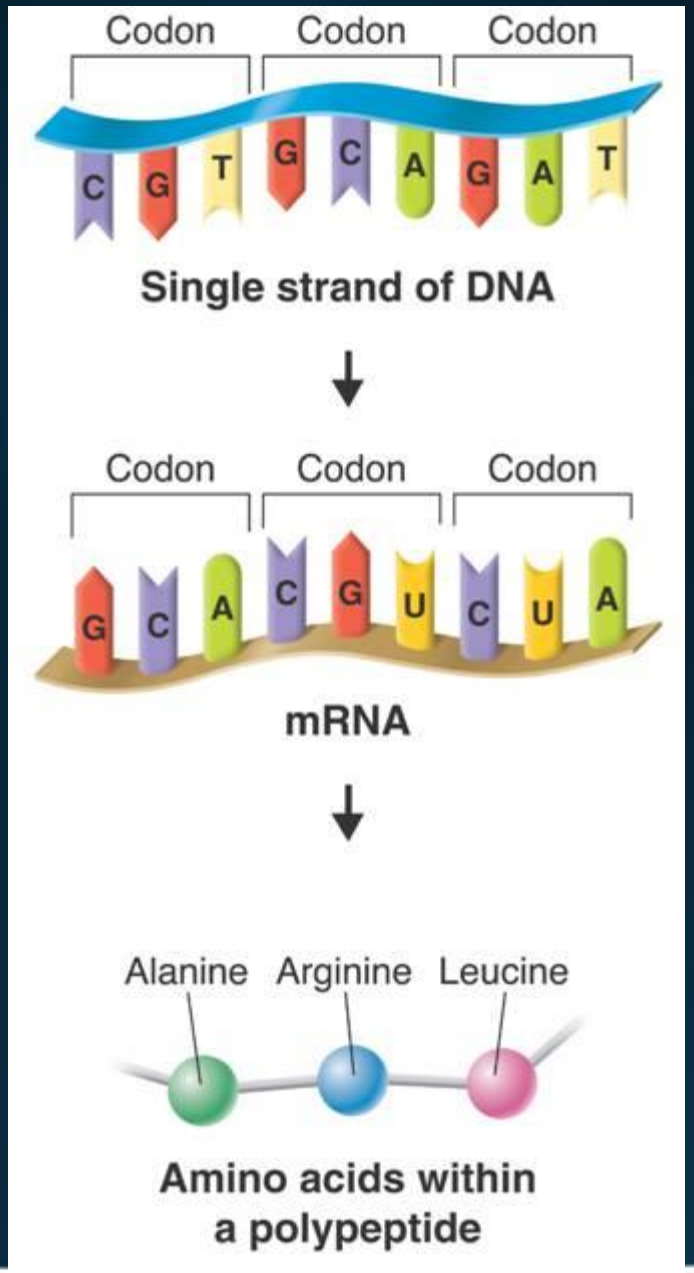
- The tRNA carries 3 unpaired bases that specify for a specific amino acid. These unpaired bases, called the anticodons, are complementary to the mRNA codon.

Roles of DNA and RNA

- The cell uses the DNA “master plan” to prepare RNA “blueprints.” The DNA stays in the nucleus.
- The RNA molecules go to the protein building sites in the cytoplasm—the ribosomes.

DNA and RNA

- The sequence of bases in DNA is used as a template for mRNA.
- The codons of mRNA specify the sequence of amino acids in a protein.



Genes and Proteins

- Genes contain instructions for assembling proteins.
- Many proteins are enzymes, which catalyze and regulate chemical reactions.

Exit Slip

- Analyzing Data- page 296

Warm Up Exercise

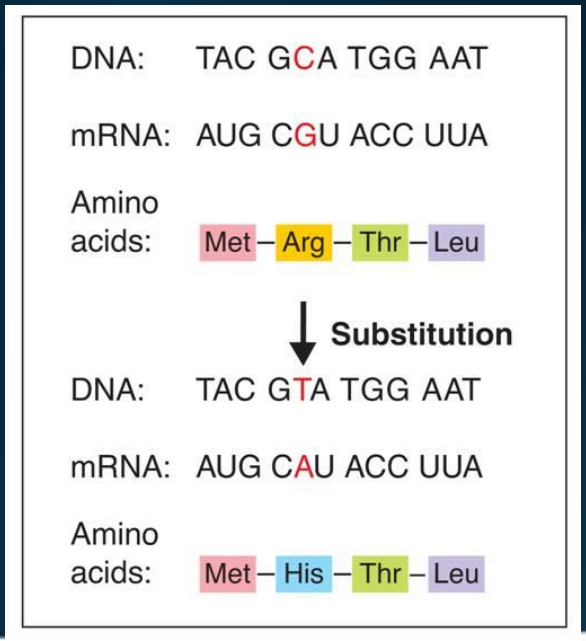
- Complete the worksheet that you picked up as you came in.

Mutations

- **Mutations**- changes in the genetic material.
  - Mutations that produce changes in a single gene are called gene mutations.
  - Mutations that produce changes in chromosomes are known as chromosomal mutations.

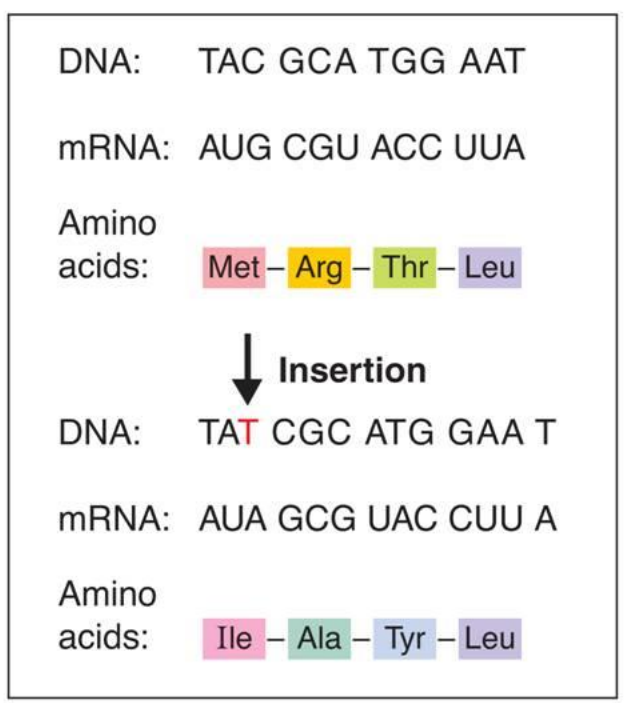
Mutations

- **Point Mutations**- gene mutations involving changes in one or a few nucleotides are known as point mutations, because they occur at a single point in the DNA sequence.
  - Ex: substitutions, insertions, and deletions



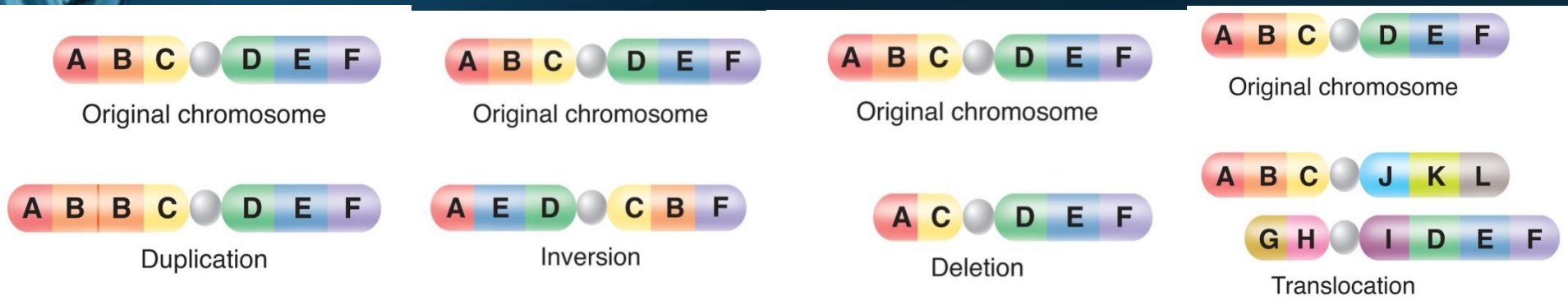
Mutations

- **<u>Frameshift Mutations</u>**- shift the reading frame of the genetic message.
  - May change every amino acid that follows from the point of mutation.
  - Ex: insertions and deletions



Mutations

- **<u>Chromosomal Mutations</u>**- involve changes in the number or structure of chromosomes. May even change the location of genes on chromosomes and the number of copies of some genes.



Significance of Mutations

- Some mutations are detrimental, although some can be beneficial.
- Mutations in sex cells can be passed along to offspring and can result in genetic variation.
- **Polyploidy**- the condition in which an organism has an extra set of chromosomes.

Exit Slip

- Design a chart comparing and contrasting types of mutations. Make three columns: Definition, Types, and Effects