Chapter 12

DNA & RNA

Experiments with "Heredity Material"

Griffith's Experiments: injected mice with bacteria that cause pneumonia

- Concluded **genetic info** is transformed from one bacteria to another

Avery & MacLeod's Experiments: repeated Griffith's experiments and used enzymes

- Concluded **DNA** is genetic info NOT **protein**

Experiments with "Heredity material"

Hershey & Chase Experiments: used viruses to determine if the DNA core or protein coat enter2s infected cells

- Concluded the **DNA core** enters the infected cell

Rosalind Franklin and Watson & Crick: developed double helix model (twisted ladder) of **DNA**

What is DNA and what does it look like?

DNA: deoxyribonucleic acid

Structure: made up of **2 strands**

Nucleotides: building blocks of DNA-consist of a **sugar** (deoxyribose), a **phosphate** group, and a nitrogenous **base**

Nitrogenous Bases: 4 types

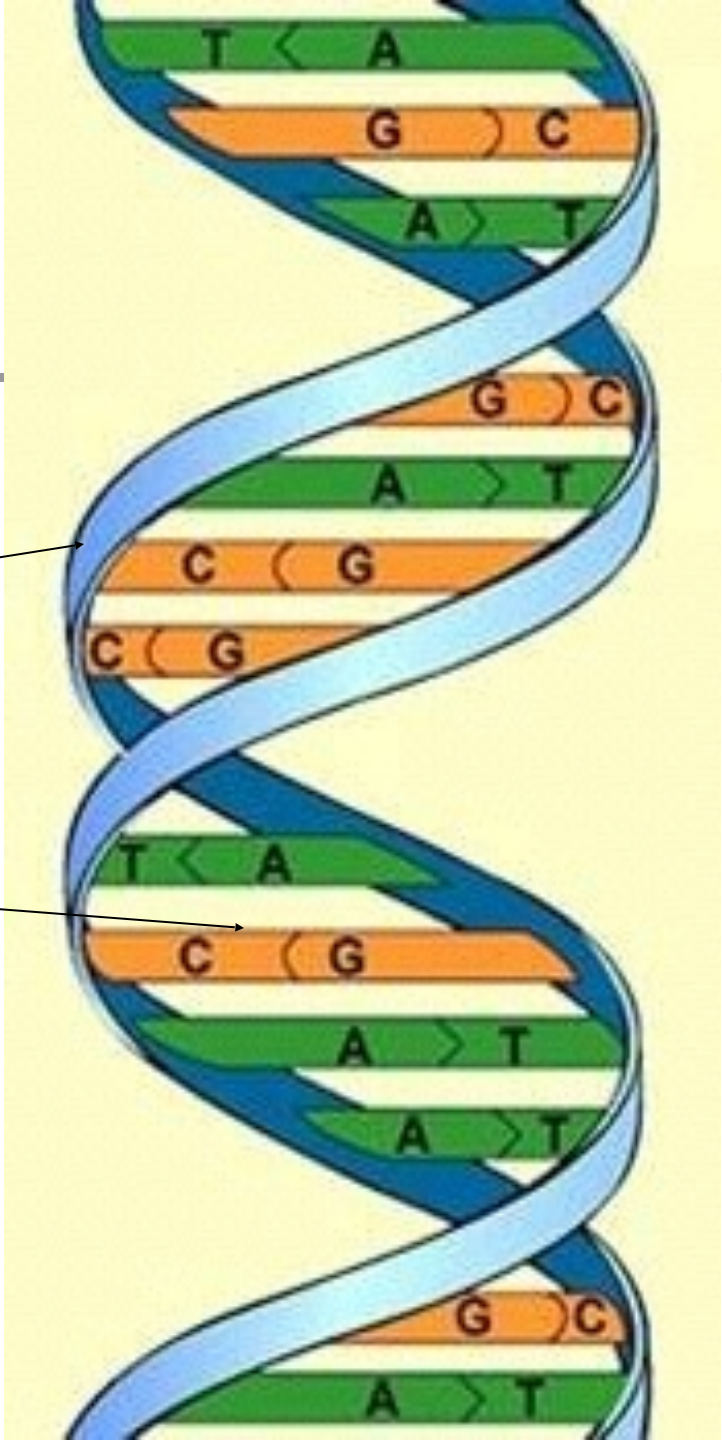
adenine (A) **thymine** (T) **guanine** (G)

cytosine (C)

DNA Molecule

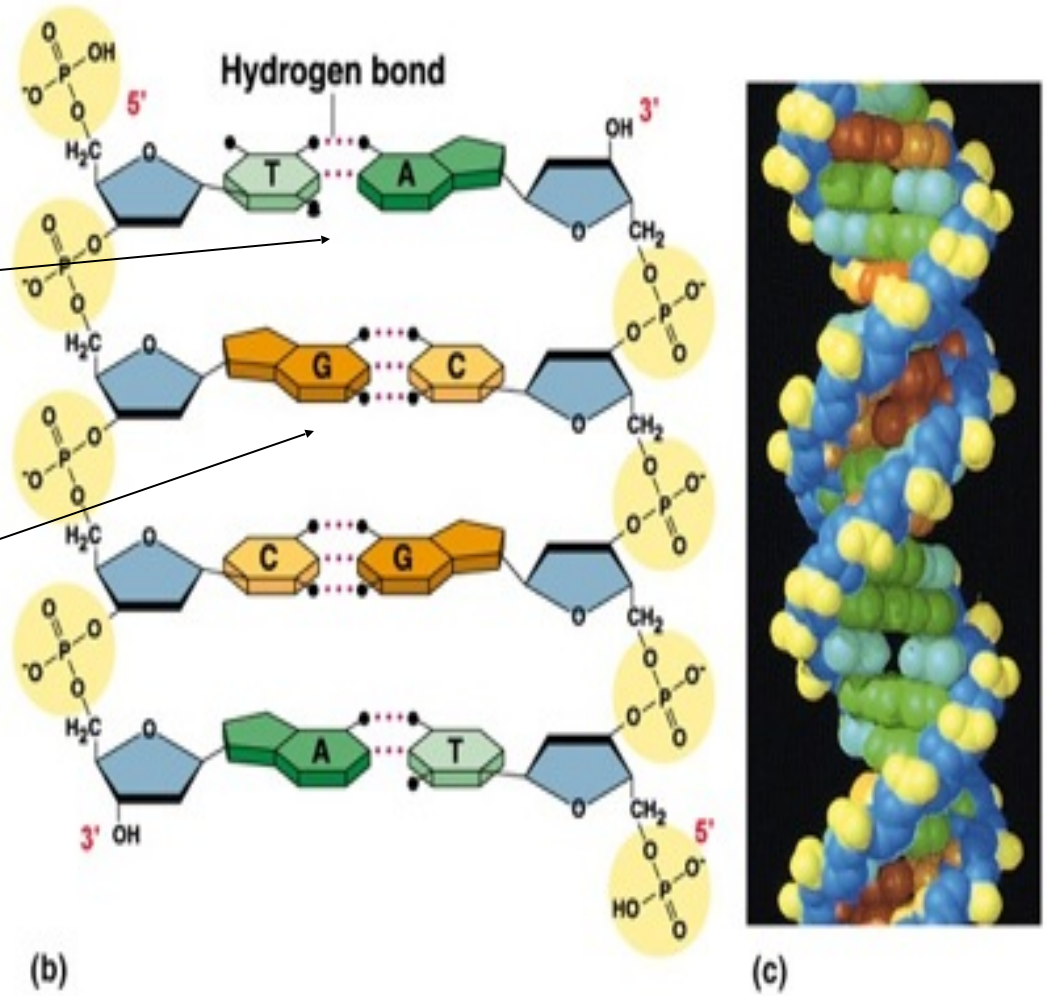
Alternating <u>sugars</u> and <u>phosphates</u>

Nitrogenous <u>Bases</u>



Chargaff's Rules for Base Pairing

- Adenine (A) **<u>bonds</u>** with Thymine (T)
- Guanine (G) **<u>bonds</u>** with Cytosine (C)



DNA Replication: copying DNA

When does it happen?

During **interphase** of the cell cycle

Template: a **model** or a **guide** for making a new strand of **DNA**

Process:

1. DNA **unzips/unwinds** and separates into **2 "parent"** strands

Replication Process cont.

2. Each strand serves as a **template** for making a new "**complimentary" strand** of DNA.
3. **Enzyme** DNA Polymerase matches the **bases** of free nucleotides to the **bases** of each **"parent"** strand of DNA (from 3' end to 5' end)

Replication Process.

4. Results in **<u>2 new identical DNA</u>** molecules, each with **<u>1 original "parent</u>**" strand and **<u>1 new complementary</u>** strand.

Protein Synthesis

- Assembly of **amino acids** to make **protein**

How do we get from DNA to what we look like?

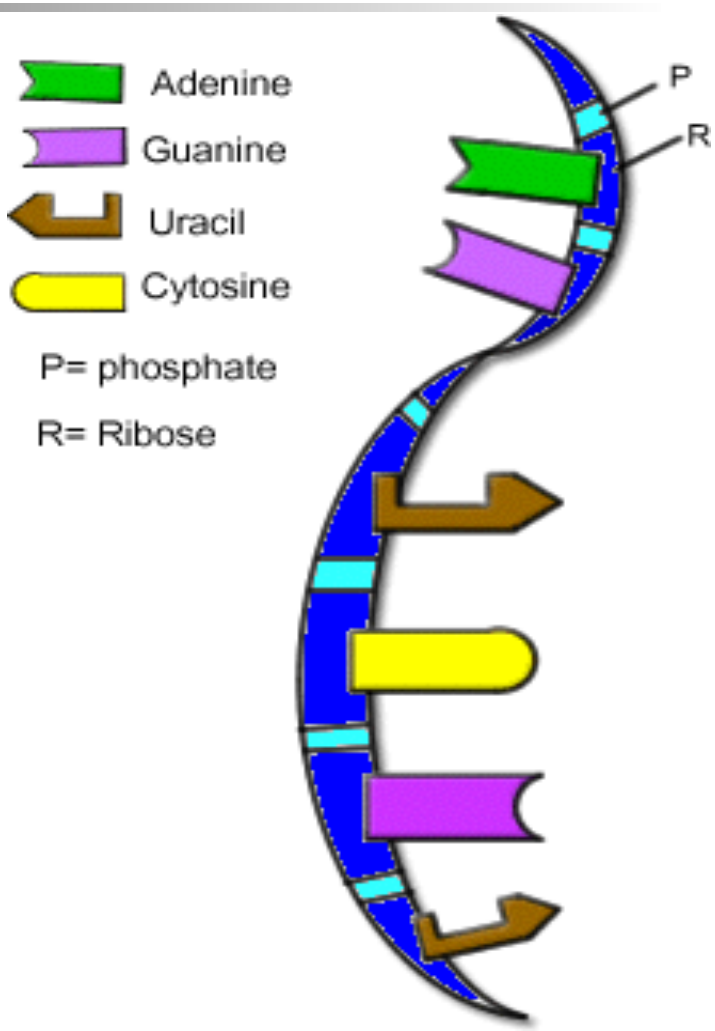
- DNA contains **instructions** for building **proteins** that determine our **traits**

RNA (ribonucleic acid)-chain of nucleotides

RNA structure: similar to DNA

3 differences:

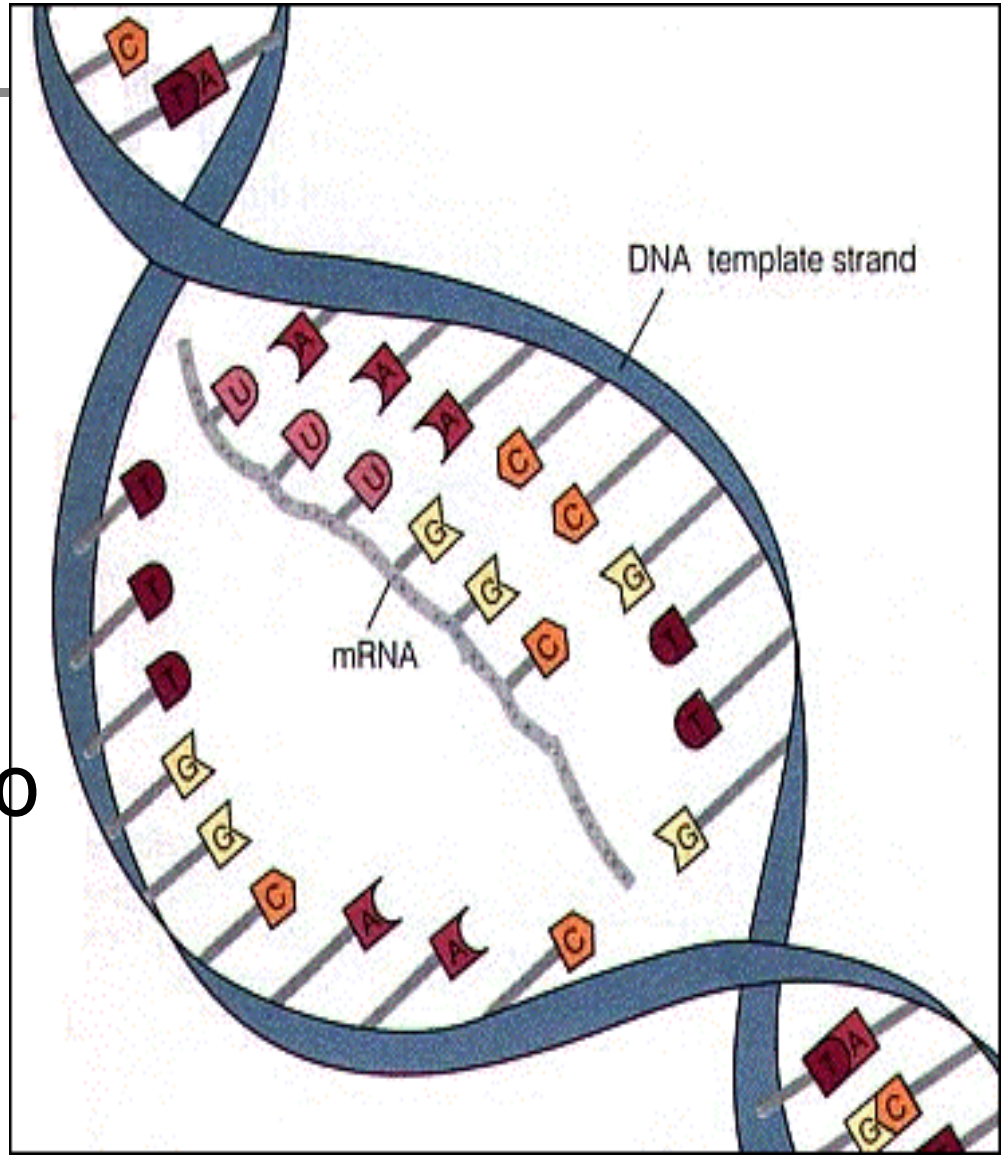
- Sugar is **ribose**
- **Single stranded**
- Has **uracil** (U) instead of **thymine** (T)



Types of RNA

mRNA (messenger RNA)

- Carries **<u>instructions</u>** for making **<u>protein</u>** from the **<u>nucleus</u>** to the **<u>ribosome</u>**



Types of RNA cont.

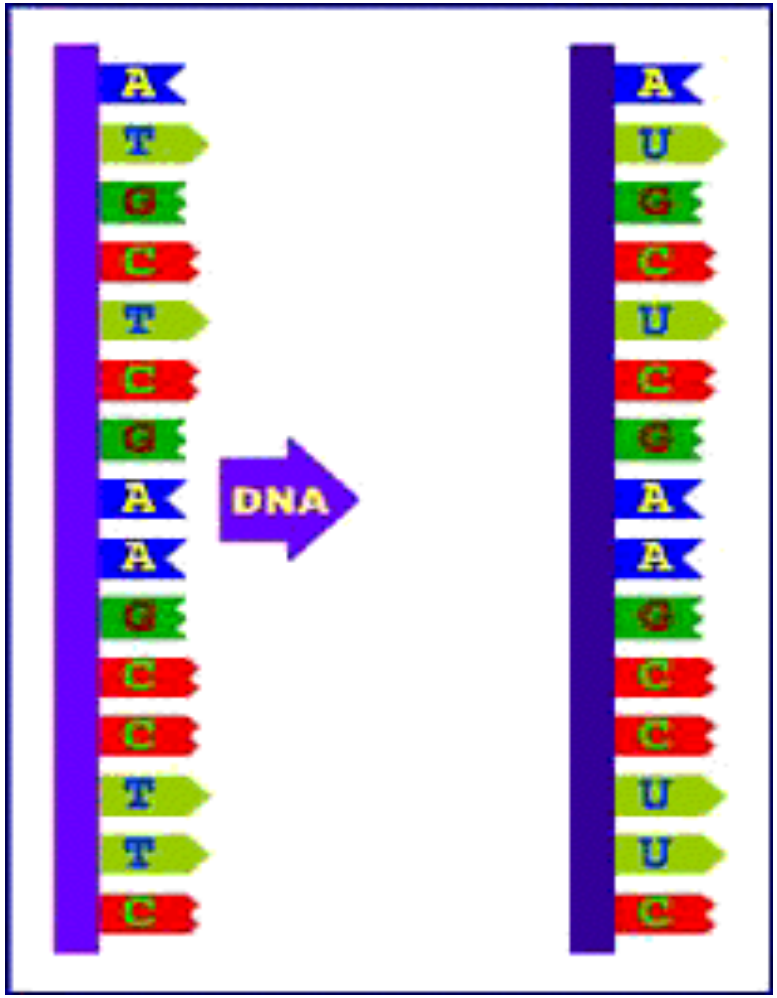
tRNA (transfer RNA)

- transfers each **amino acid** to the **ribosome** based on the **mRNA code**

Transfer RNA

How is RNA made?

- part of the sequence of **DNA** is copied into a **"complementary"** sequence of **RNA**
- This process is called **transcription**



Protein Synthesis

Involves two processes:

- **Transcription:** from **DNA to RNA** (occurs in the **nucleus**)
- **Translation:** from **mRNA** to a chain of **amino acids** (occurs in the **ribosome**)

Protein Synthesis cont.

How does the enzyme know where to start and stop copying DNA into RNA?

- By reading start and stop **codons**

  (3 unpaired **bases** that code for a specific **amino acid**)
- **Start codon** = AUG
- **Stop codons** = UGA, UAA, UAG

Steps to Protein Synthesis

1. **Enzyme** RNA polymerase transcribes **DNA** into **RNA.**

   Ex: TTG CAC -----→ AAC GUG

   (DNA) (RNA)

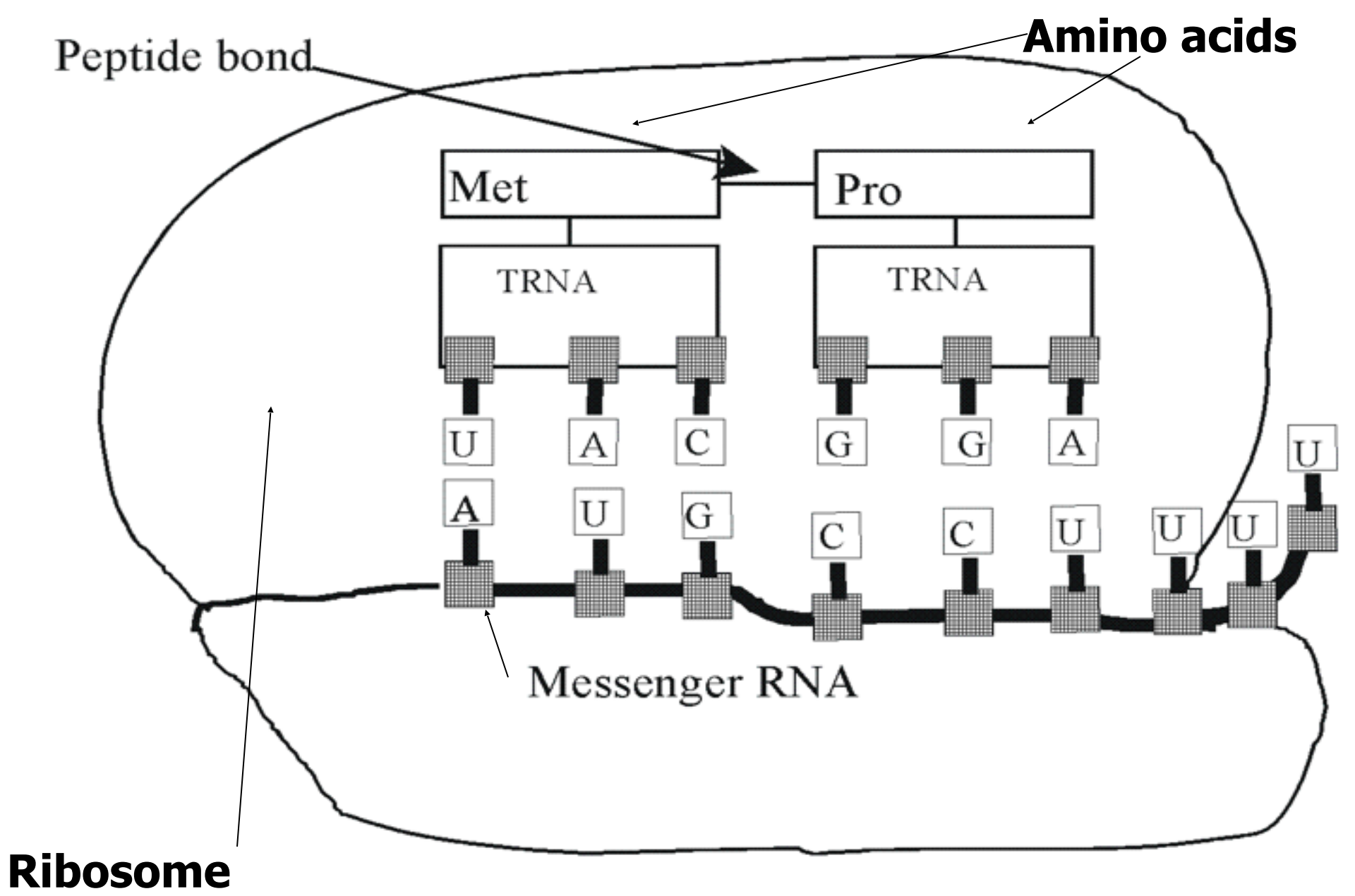
2. **mRNA** brings the code from the **nucleus** to the **ribosome**

Steps to Protein Synthesis Cont.

3. **tRNA** molecules bring **amino acids** from the **cytoplasm** to the **ribosome** based on the **mRNA code**
4. tRNA **anticodons** (3 unpaired **bases** which are **complementary** to **mRNA** codons) bond with mRNA codons

Steps to Protein Synthesis cont.

5. Peptide bonds form between the amino acids
6. tRNA molecules return to the cytoplasm and the ribosome moves down the mRNA strand
7. This process continues until a STOP codon is reached


Peptide bond
Amino acids
Met
Pro
TRNA
TRNA
U
A
C
G
G
A
A
U
G
C
C
U
U
U
U
Messenger RNA
Ribosome

Steps to Protein synthesis cont.

8. At this point, a protein has been made and both the mRNA and protein are released from the ribosome.

Summary of Protein Synthesis

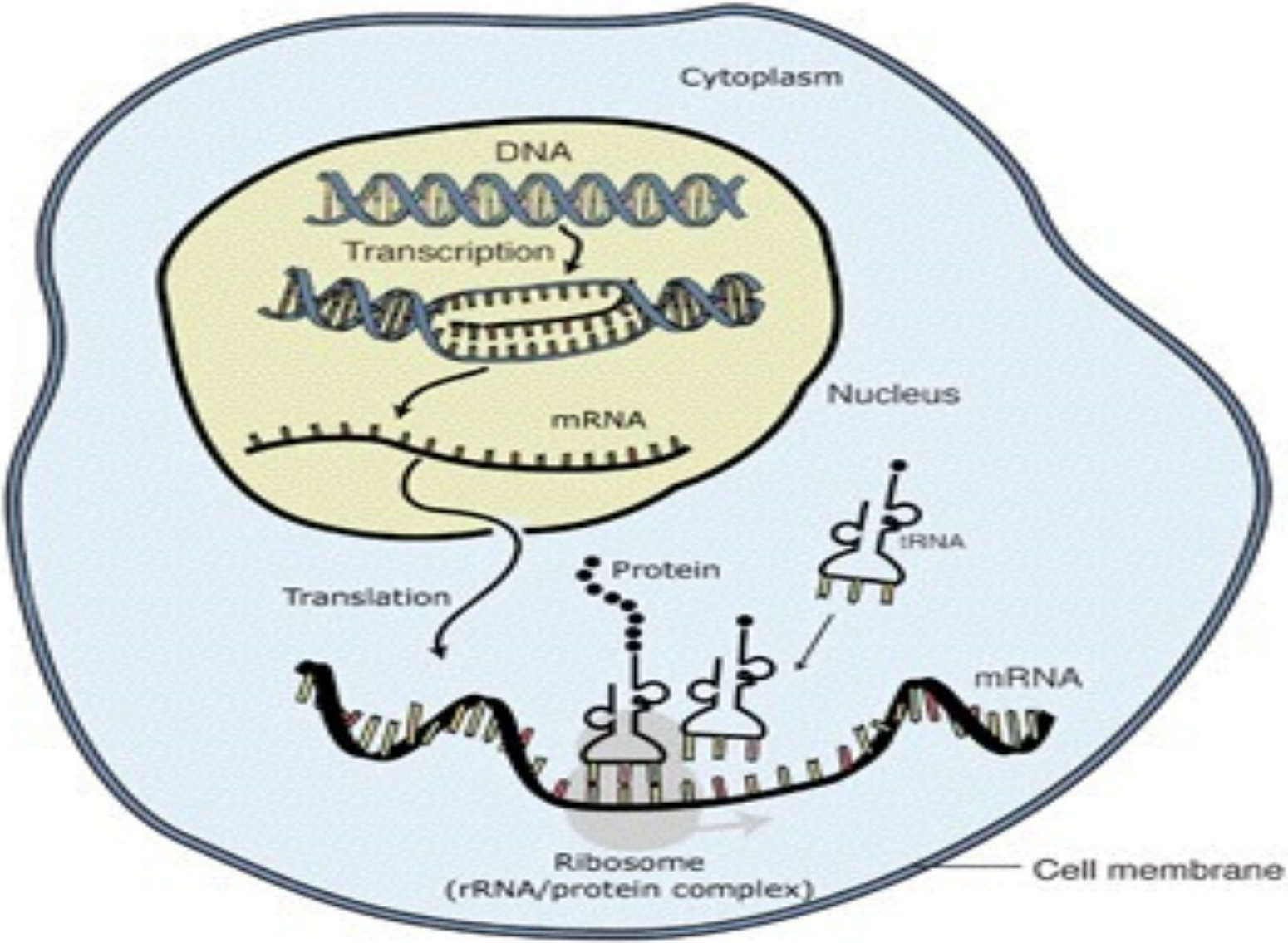


Image adapted from: National Human Genome Research Institute.

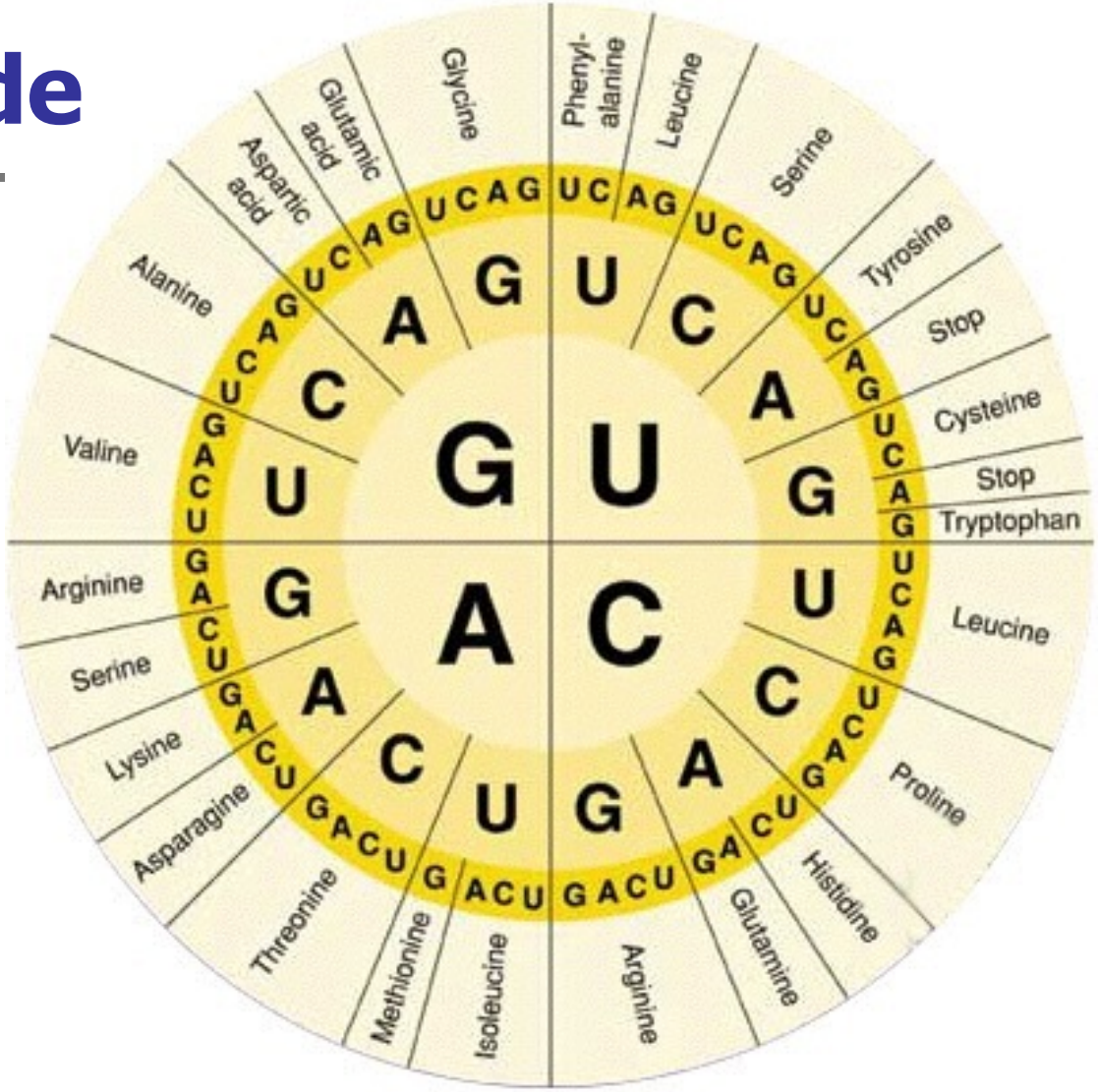
Genetic Code

- Use mRNA codons
- Begin in middle and work your way out
- Examples:

  GUU=Valine

  ACG= Threonine

  CGA= Arginine



Genetic Code cont.

- Use mRNA codons
- Find 1st letter on the left
- Find 2nd letter across the top
- Find 3rd letter on the right
- Amino acid is where they meet
- Ex: UUG= Leu

Second letter

First letter	U	C	A	G	Third letter
U	UUU, UUC Phe UUA, UUG Leu	UCU, UCC, UCA, UCG Ser	UAU, UAC Tyr UAA Stop 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	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

Mutations: changes in DNA

A. **<u>Gene mutations:</u>** changes in specific bases in DNA that effect genetic info

- **Point mutation/substitution:** a change in one base at a single point in the DNA

ex: **<u>AAA</u>** CCC GTC → **<u>ATA</u>** CCC GTC

- Results in a change in one amino acid

Mutations cont.

- **Frameshift mutation: 2 types**

  1. **insertion:** a base is added to DNA

  ex: AAA CCC **GTC** → AAA CCC **TGTC**

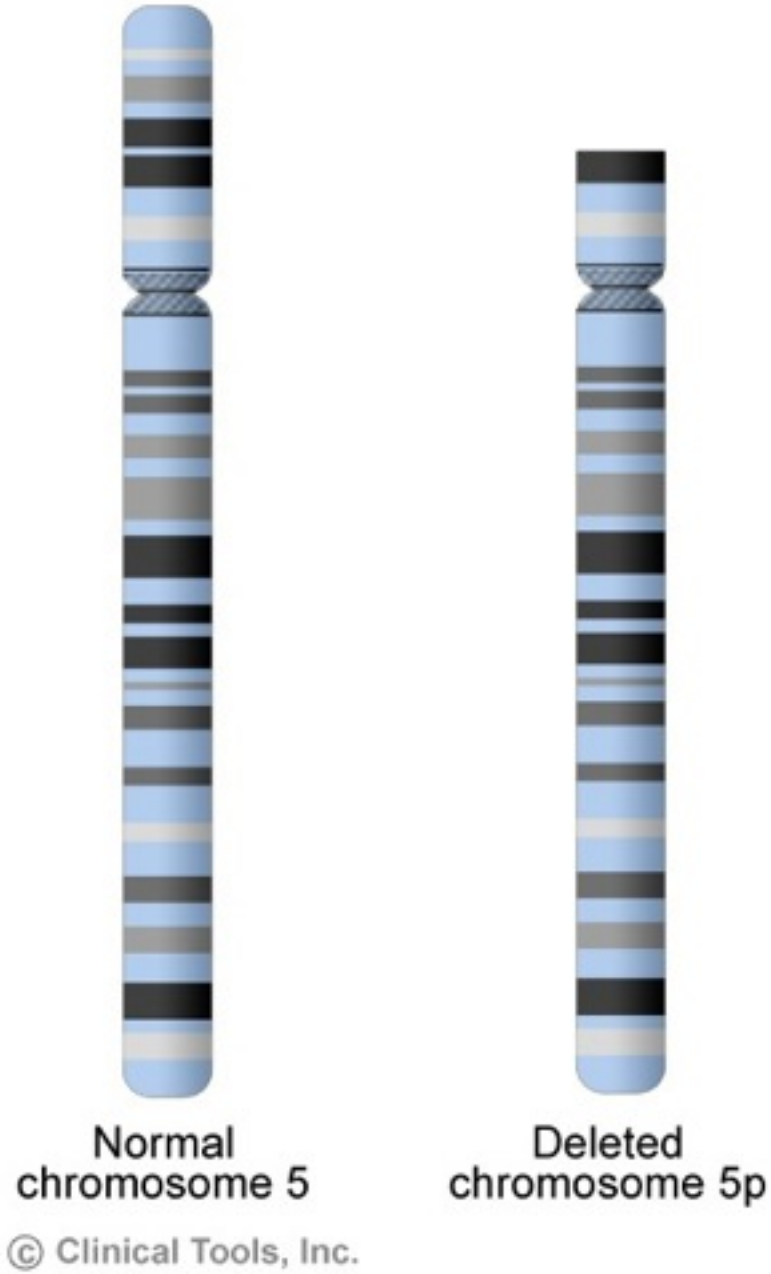
  2. **deletion:** a base is removed from DNA

  ex: AAA CCC **GTC** → AAA CCC **TC**

Mutations cont.

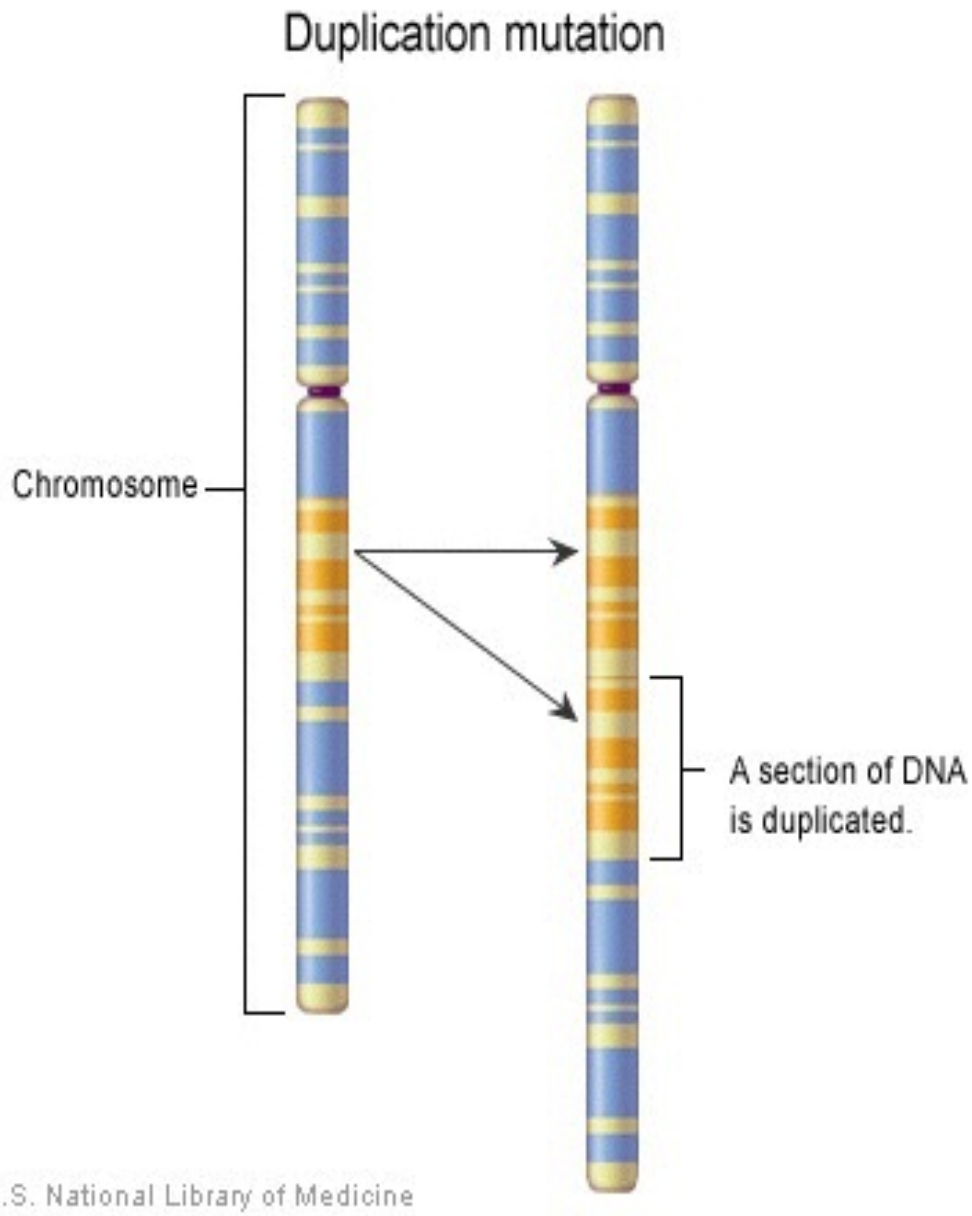
b. **Chromosomal mutations:** changes in the # or structure of chromosomes

- **Deletion:** removal of all or part of a chromosome



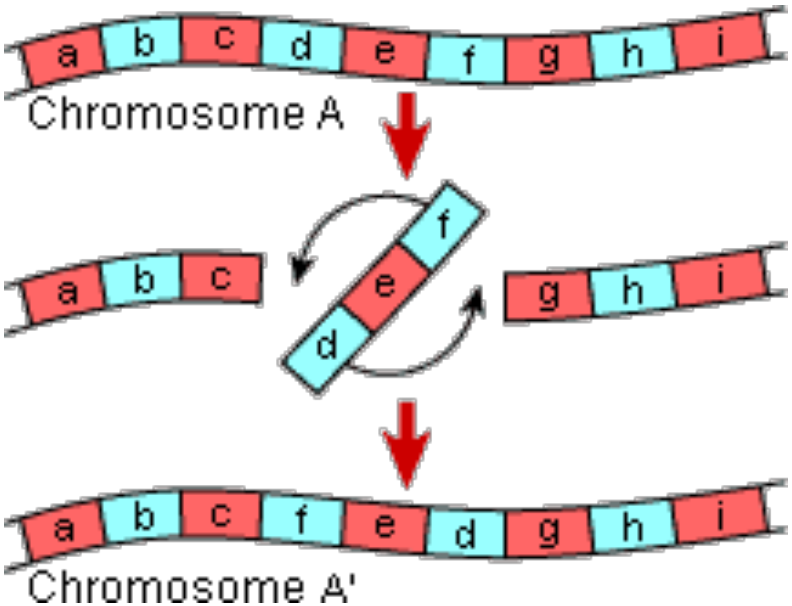
Mutations co

- **Duplication:** a segment of a chromosome is repeated



Mutations cont.

- **Inversion:** part of a chromosome becomes oriented in the reverse direction



Mutations cont

- **Translocation:** pa
  of one chromosome
  breaks off and
  attaches to another
  chromosome