LECTURE 10

Dr. Sameer Hasan Qari

# Mutation

المملكة العربية السعودية
وزارة التعليم
جَامِعَةُ أمّ القُرىٰ
الكلية الجامعية بالجموم
قسم الاحياء
Dr. M. A. Fouad

# WHAT ARE MUTATIONS?

## Mutation: Definition

- Permanent **changes** in **nucleotide sequence**.
- A **heritable alteration** or change in the **genetic material**.
- Mutation = any change in a DNA sequence

**What if this DNA…**

CACGTGGACTGAGGACTCCTC

**was changed to this DNA?**

CACGTGGACTGAGGACACCTC

**What does it matter???**

**What if this DNA…**

CACGTGGACTGAGGACTCCTC

**was changed to this DNA?**

CACGTGGACTGAGGACACCTC

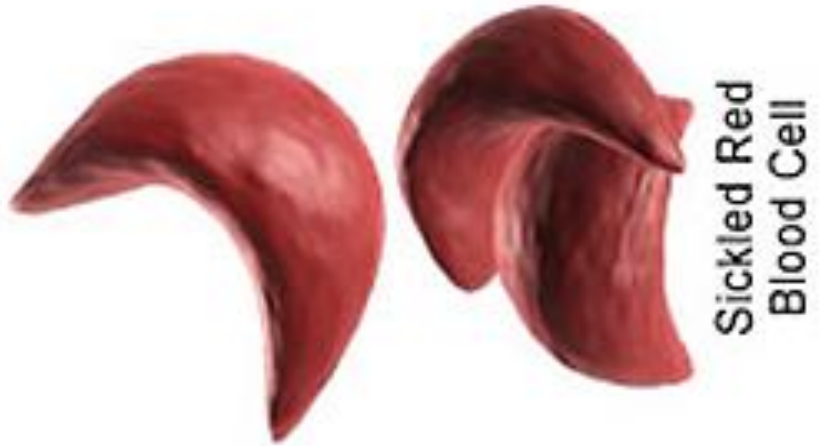
**What does it matter???**

CACGTGGACTGAGGACTCCTC

Codon for CTC = glutamate

CACGTGGACTGAGGACACCTC

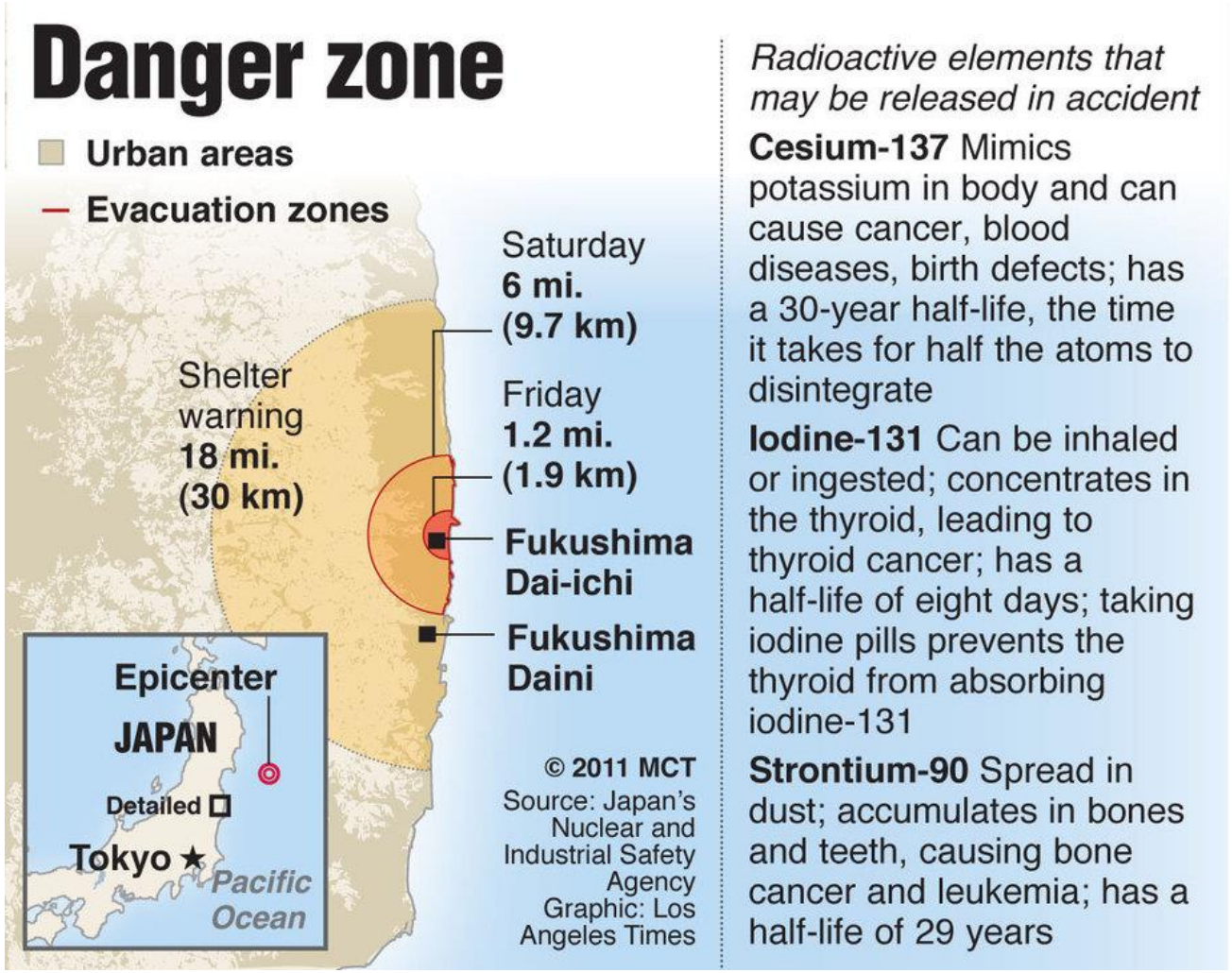
Codon for CAC =valine





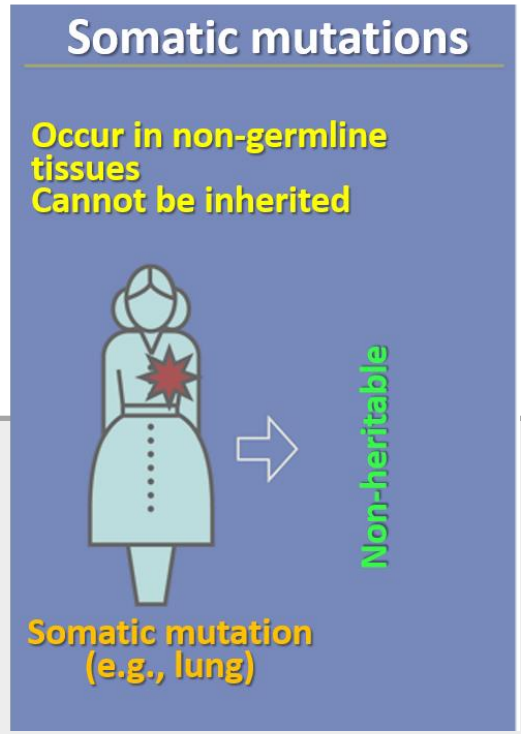
# That what does it matter

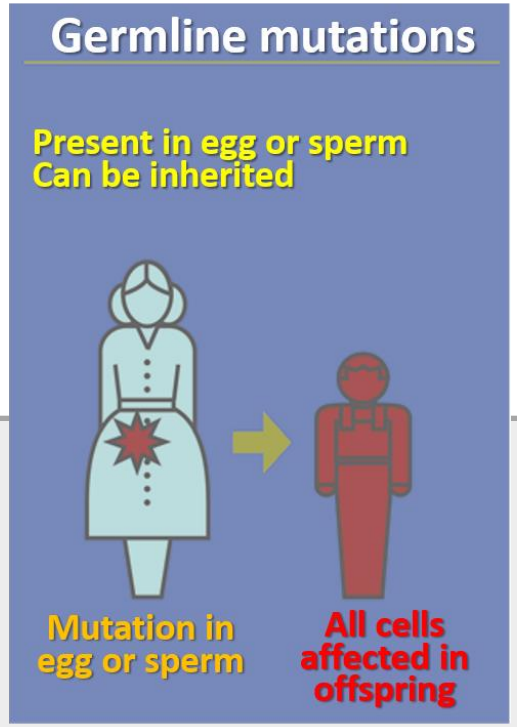
# What's Happening in Japan





| | |
|---|---|
| **Somatic mutations occur in "body" of organism (somatic cells).** | **Germ-line mutations-occur In cells producing gametes (gonadal tissue).** |
| A mutation arising in a somatic cell cannot be transmitted to offspring. | Germ-line mutations can be transmitted to future generations. |



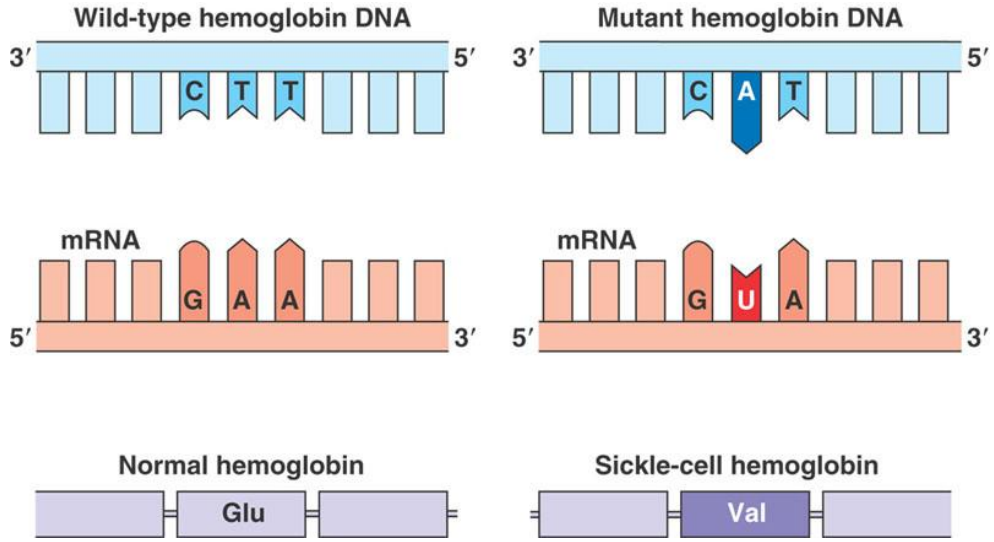

# Mutations: Somatic and Germline

Mutation could be in **somatic cells** or **germ-line cells**.

# Types of Mutations

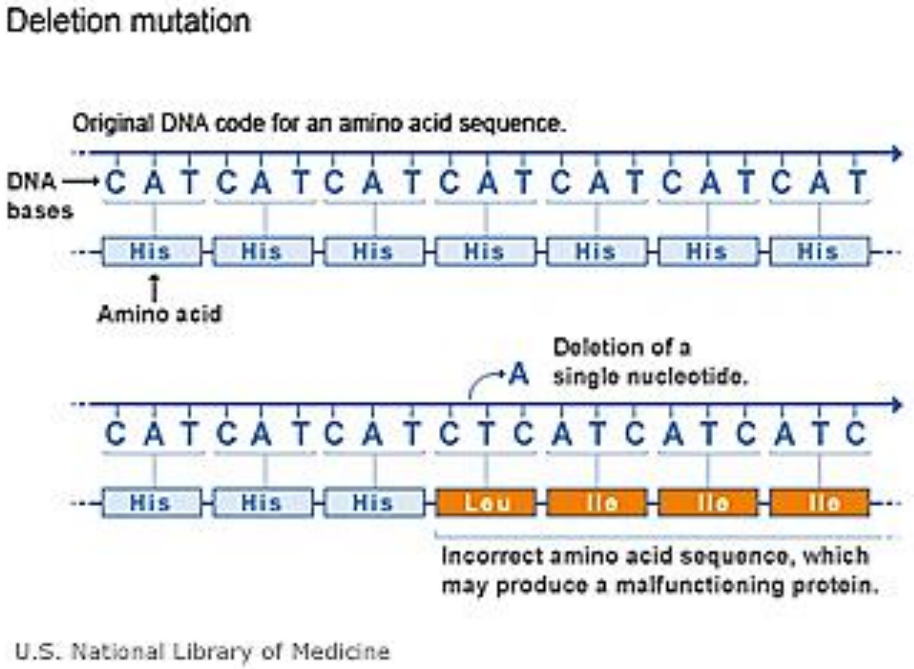
1. **gene mutations** – only affects one gene (point mutation)

   **A- substitution** of a single base pair - changes only one amino acid (if any!)



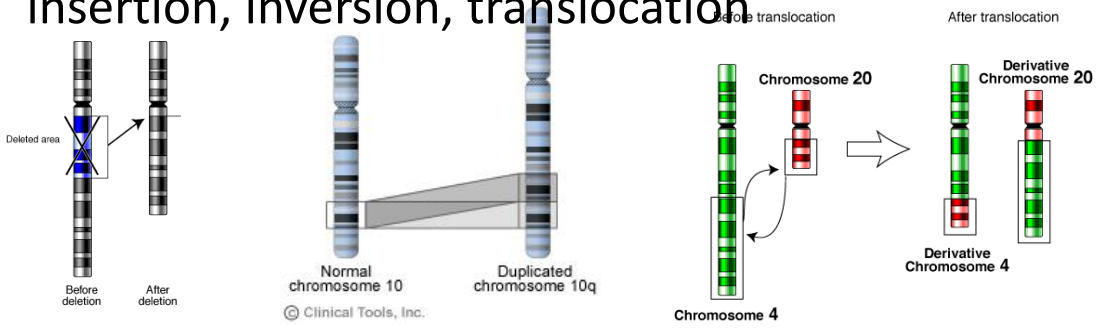

   **B-frameshift mutation**

   - a single base is added or deleted - changes every amino acid after mutation site (**also called a nonsense mutation**)

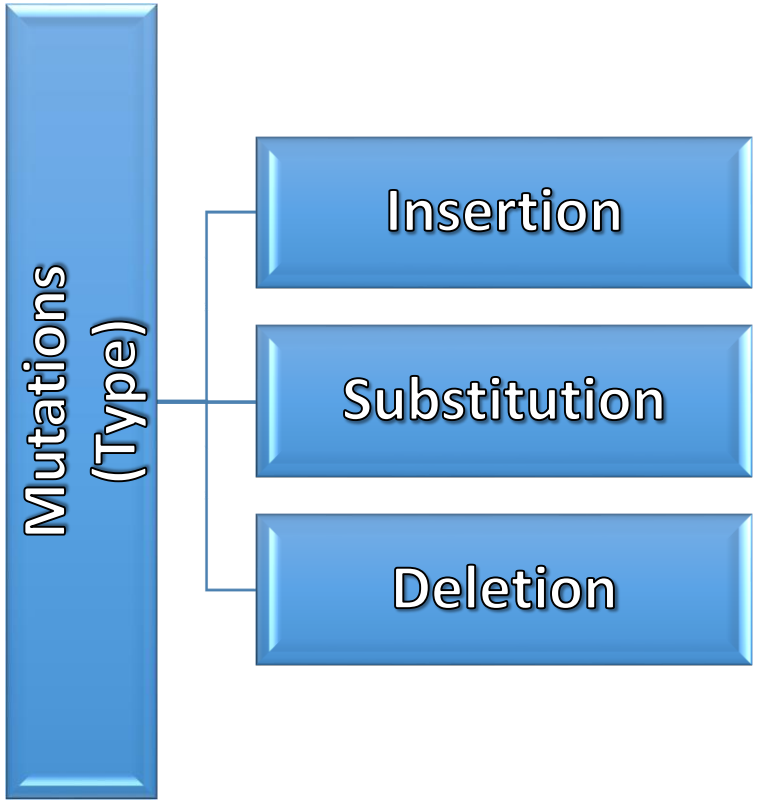


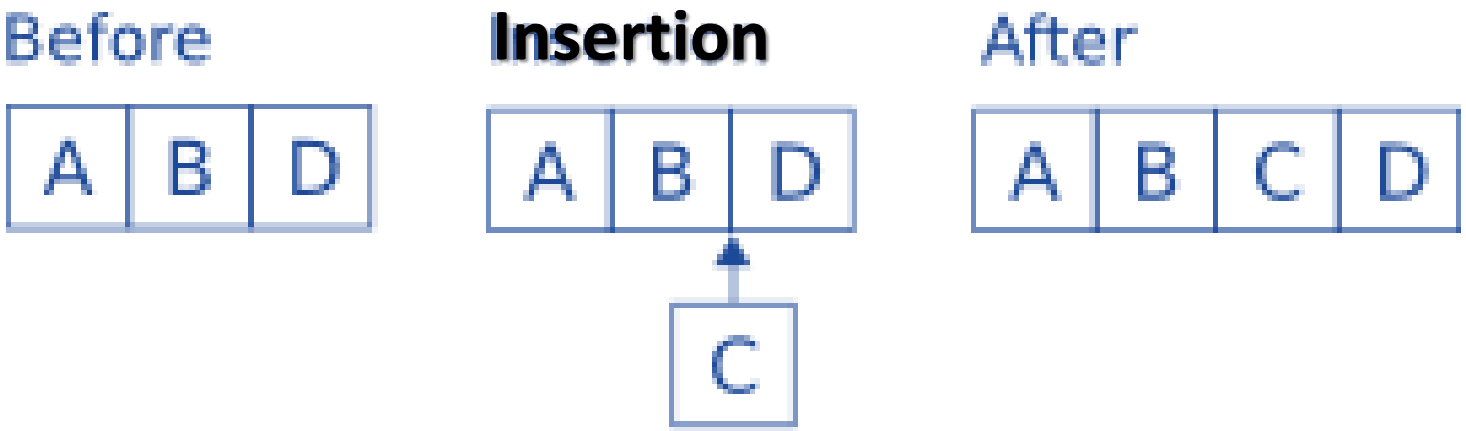

2. **Chromosomal mutation** – may affect more than one gene

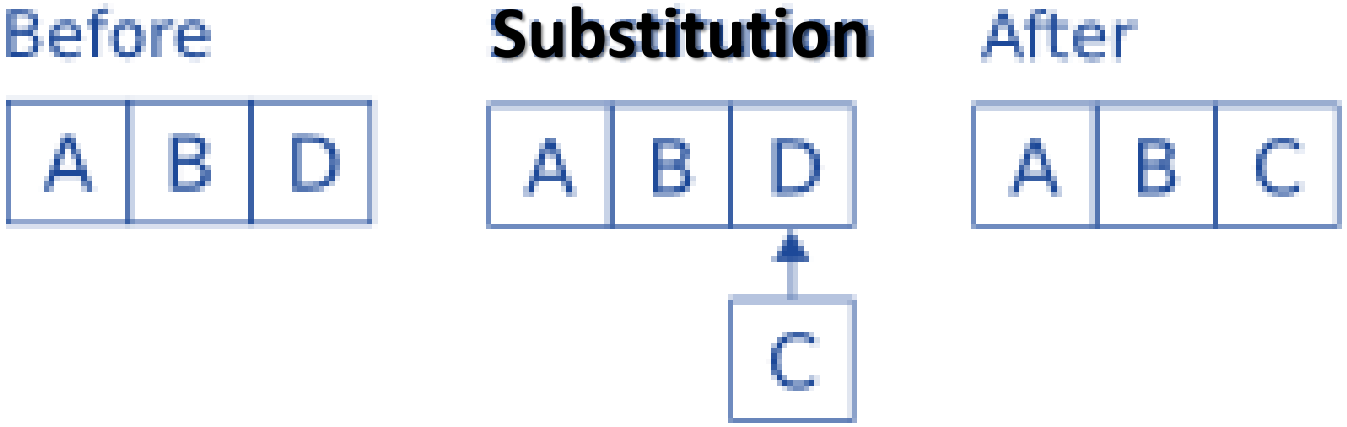
   -Examples: nondisjunction, deletion, insertion, inversion, translocation

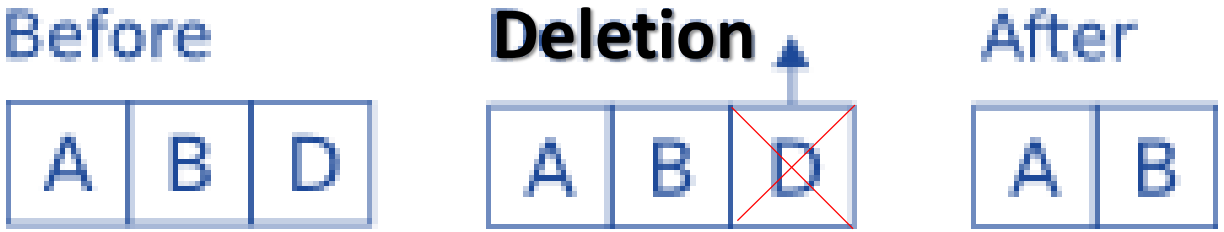


# Types of mutations



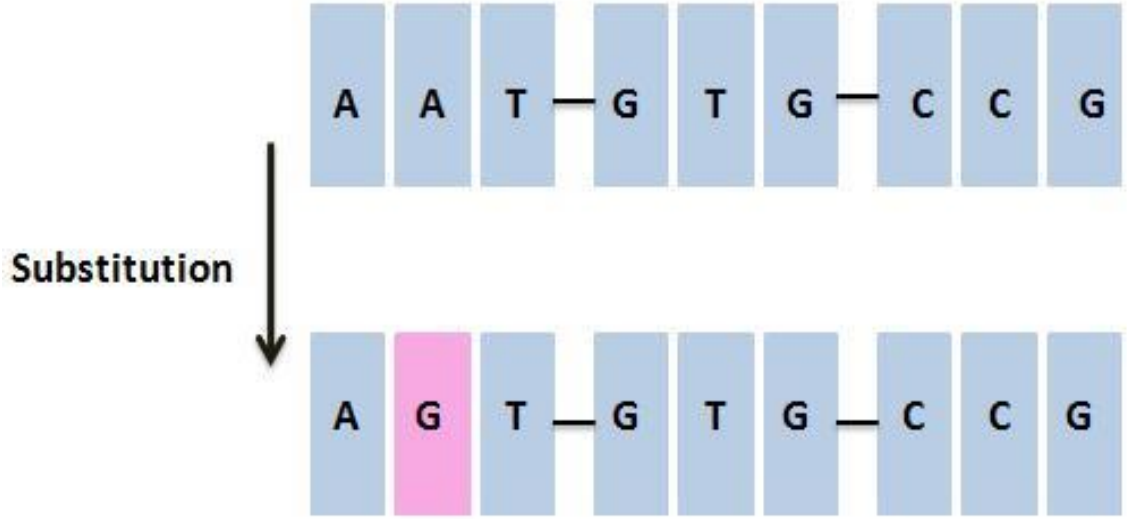



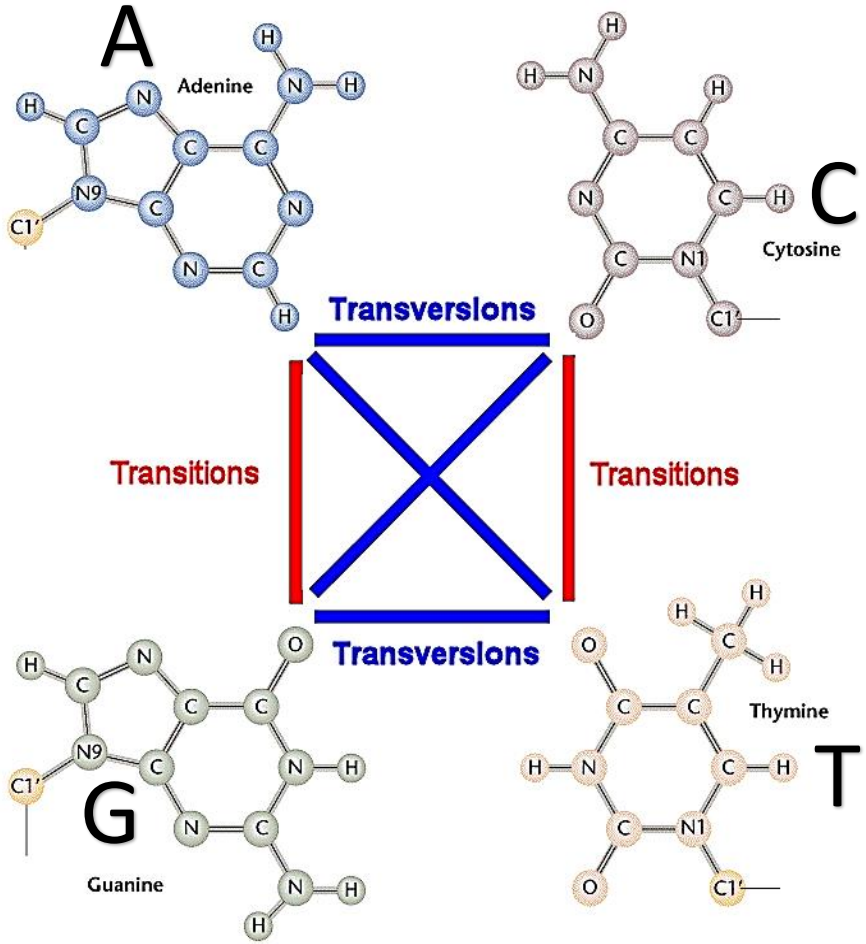
# 1. Substitution

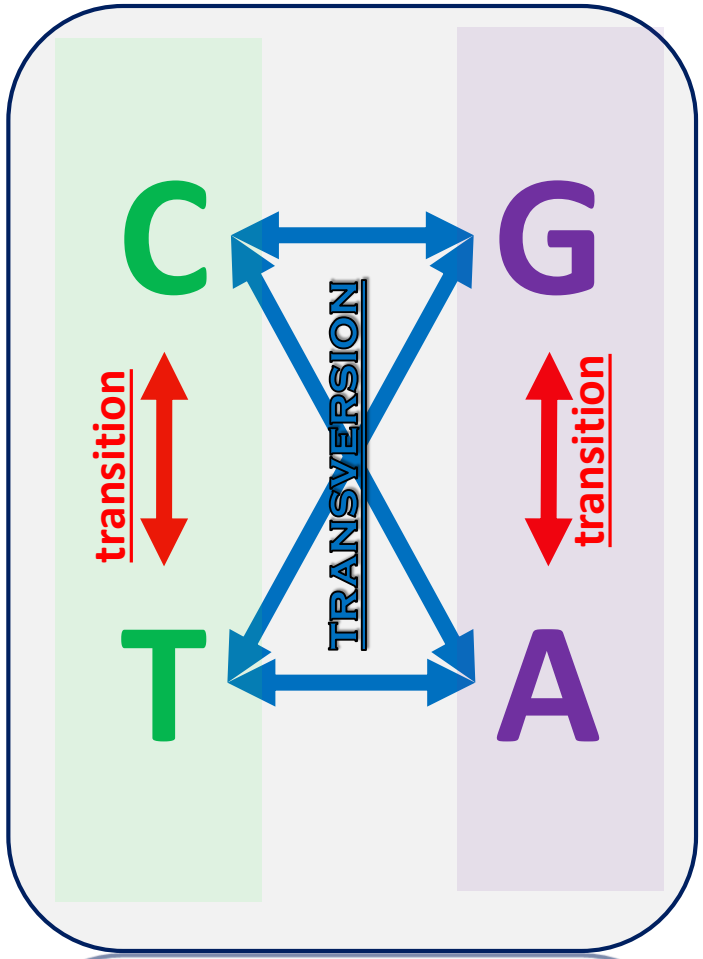
- A substitution is the **replacement** of a single nucleotide by another.
- This is the **most common** type of mutation.




# Substitution: transition vs. transversion

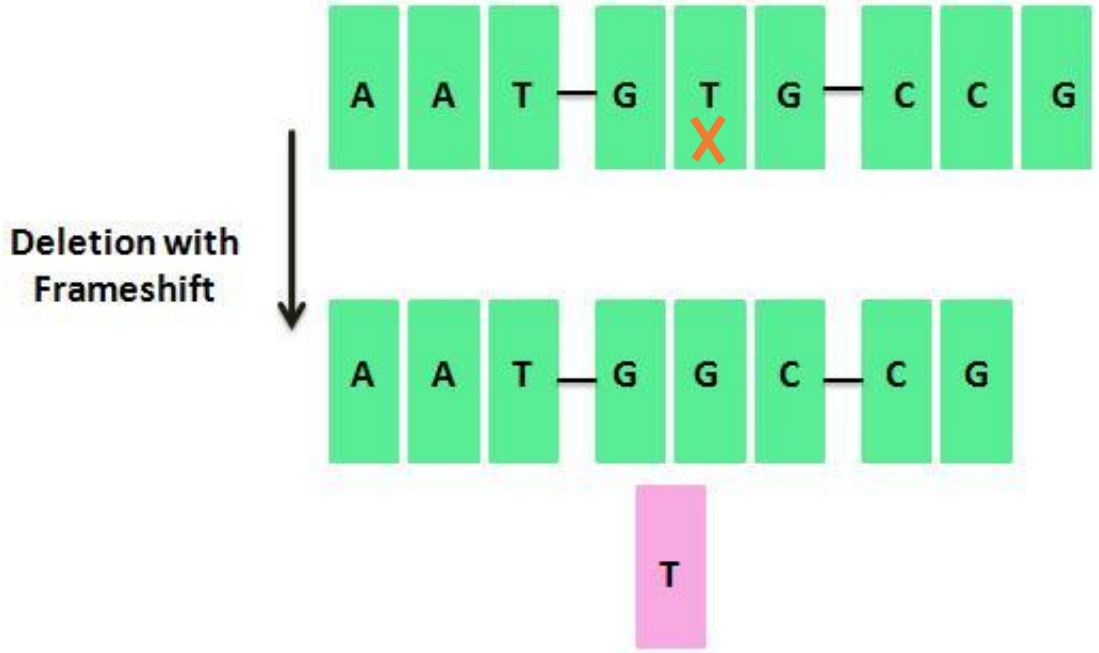
- If the substitution involves replacement by the **same type** of nucleotide,
  i.e. a **pyrimidine** for a **pyrimidine**
  or a **purine** for a **purine**,
  → this is termed a **transition**.
- Substitution of a **pyrimidine** by a **purine** or vice versa is termed a **transversion**.

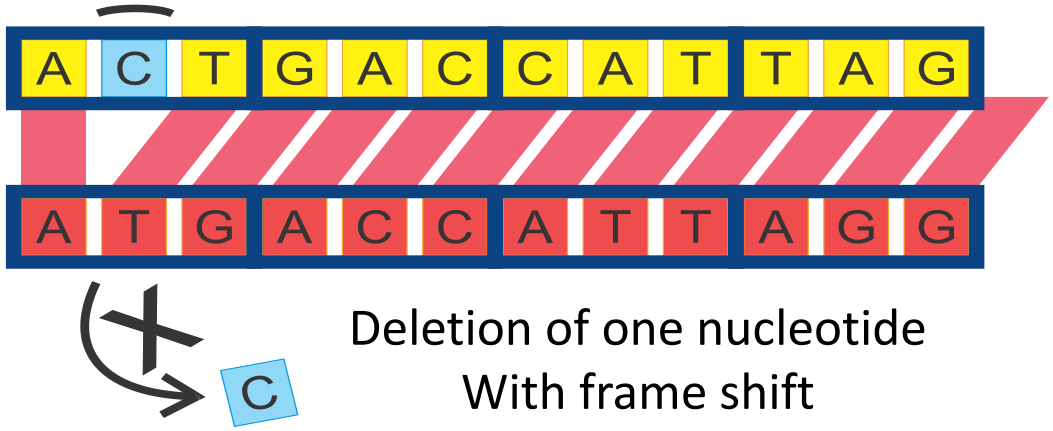


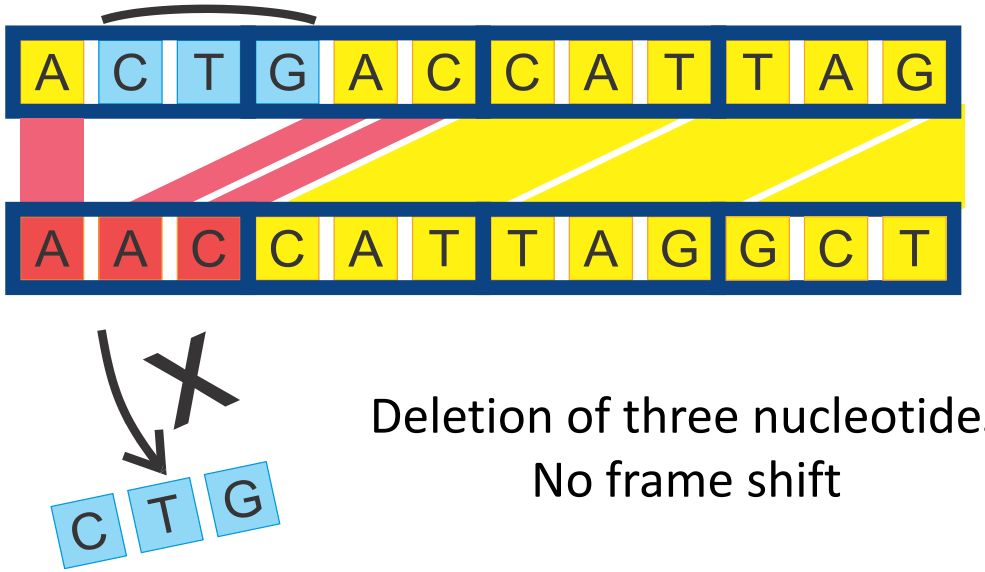
# 2. Deletion

- A deletion involves the loss of one or more nucleotides.
- If it occurs in coding sequences and involves one, two or more nucleotides which are **not a multiple of three**, it will disrupt the **reading**



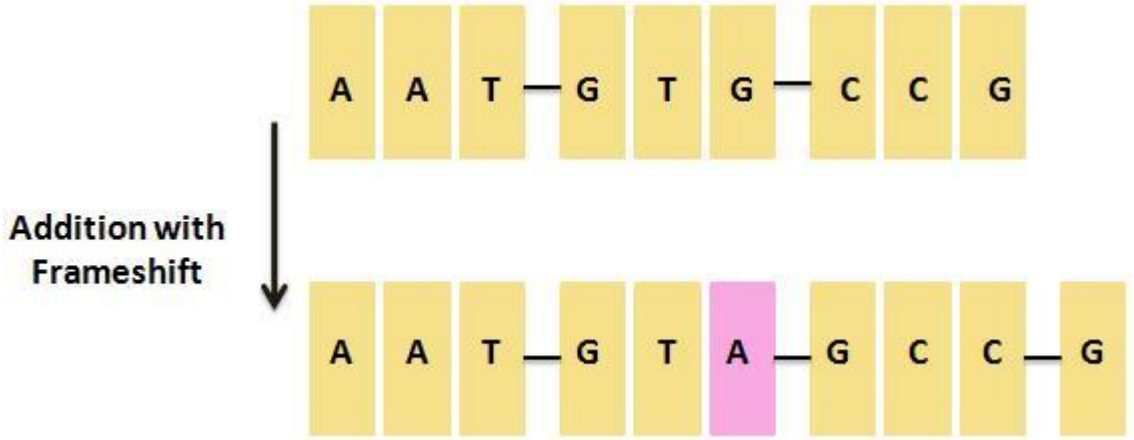

Deletion of one nucleotide
With frame shift

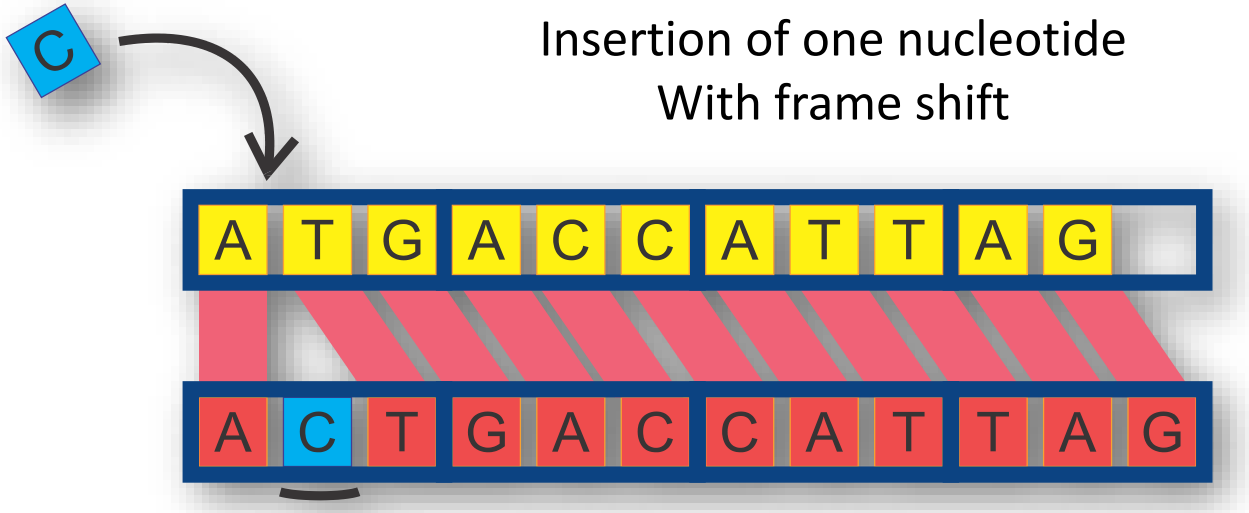



Deletion of three nucleotides
No frame shift

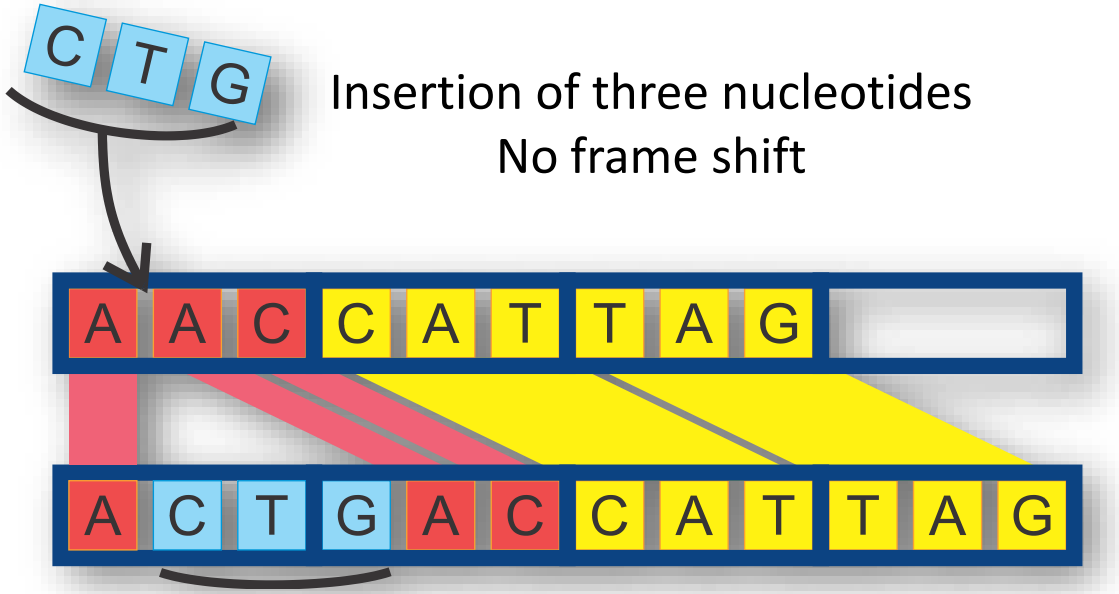
# 3- Insertions

- An insertion involves the addition of one or more nucleotides into a gene.
- If an insertion occurs in a coding sequence and involves one, two or more nucleotides which are **not a multiple of three**, it will disrupt the reading frame.




Insertion of one nucleotide
With frame shift



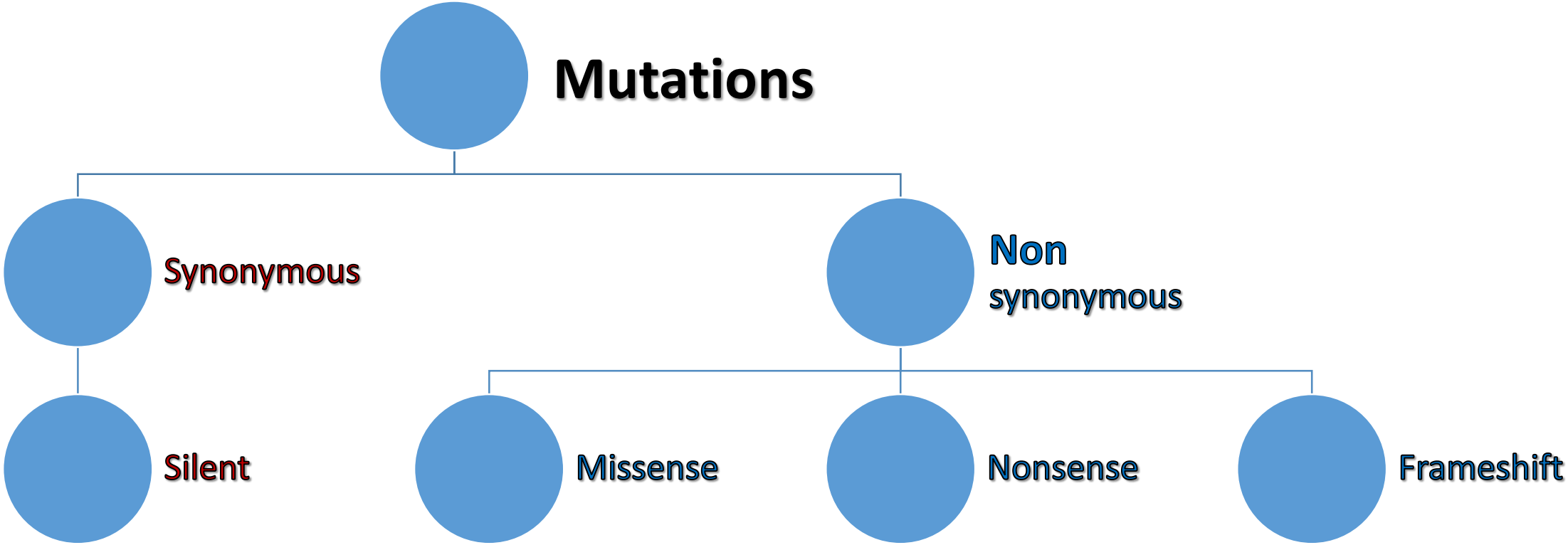

Insertion of three nucleotides
No frame shift

# Concept Check 1

**Which of the following changes is a transition base substitution?**

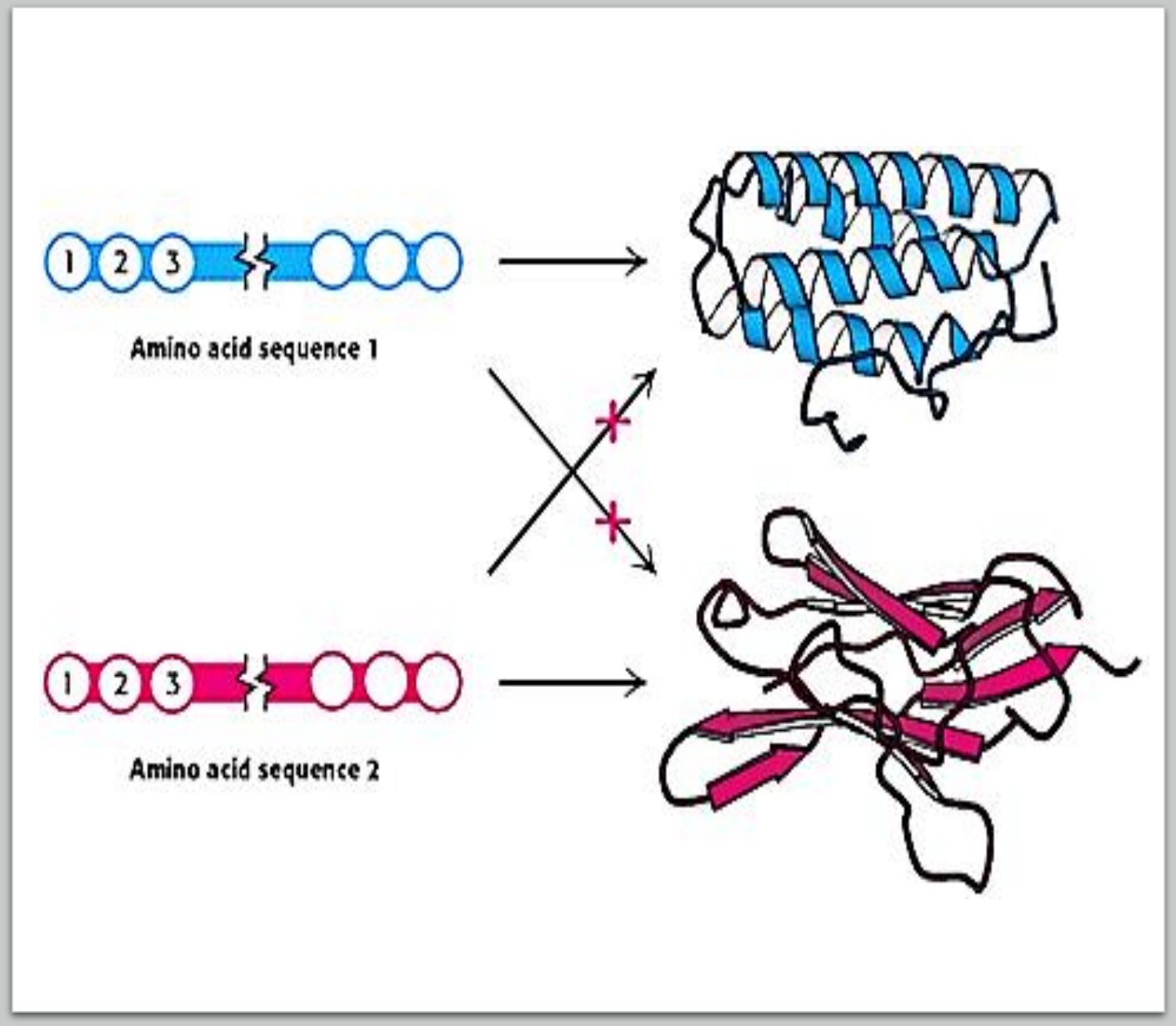
a. Adenine is replaced by thymine.
b. Cytosine is replaced by adenine.
c. Guanine is replaced by adenine.
d. Three nucleotide pairs are inserted into DNA.

# Effects of mutations on the protein



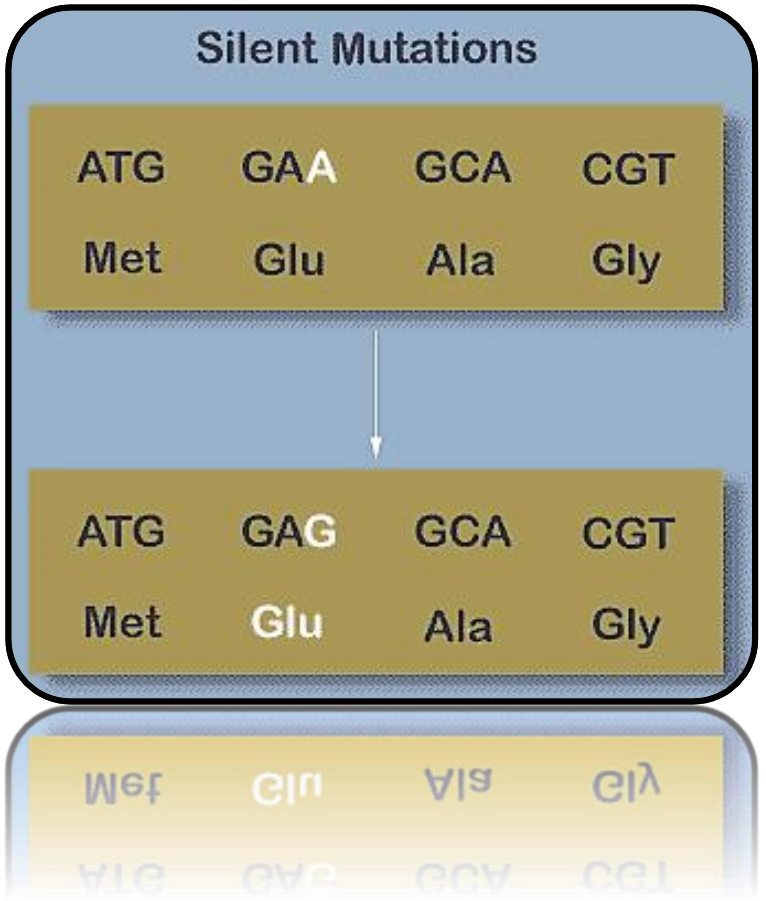
# Structural effects of mutations on the protein

- Mutations can also be subdivided into two main groups according to the effect on the polypeptide sequence of the encoded protein, being either:
  - **Synonymous (Silent)** Mutation or
  - **non-synonymous Mutation**.



# A- Synonymous/silent mutations

- If a mutation **does not alter the polypeptide product** of the gene, this is termed a synonymous or silent mutation.
- A **single** base pair substitution, particularly if it occurs in the **third position of a codon**, will often result in another triplet which codes for the **same amino acid** with no alteration in the properties of the resulting protein.

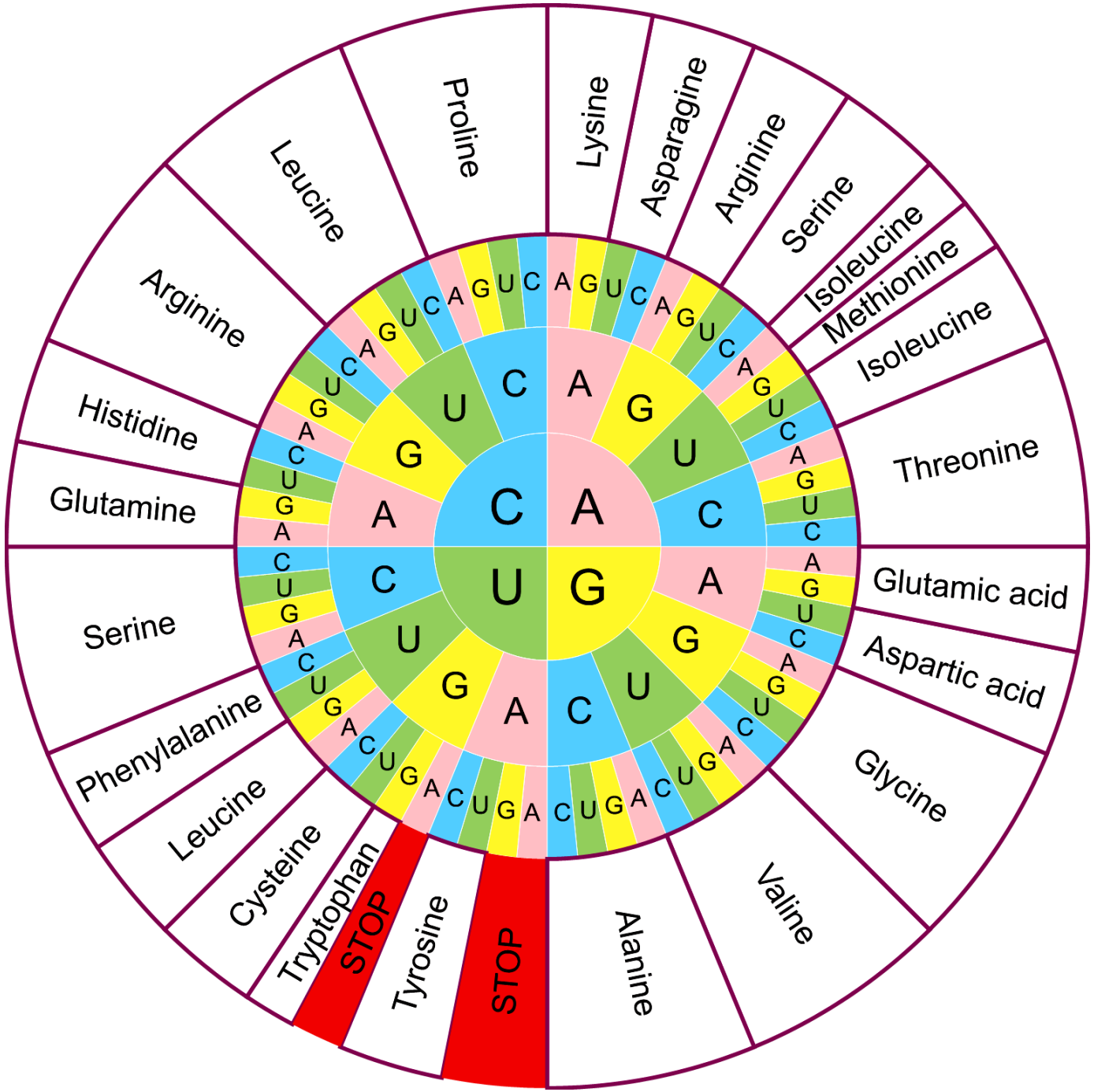


# you see

**You Must Be know some thing about the Codon vs. Amino acids**

# Genetic code

The **genetic code** is the set of rules used by living cells to translate information encoded within genetic material (DNA or mRNA sequences) into proteins. Translation is accomplished by the ribosome, which links amino acids in an order specified by messenger RNA (mRNA), using transfer RNA (tRNA) molecules to carry amino acids and to read the mRNA three nucleotides at a time., called *codons*, specify which amino acid will be added next during protein synthesis.



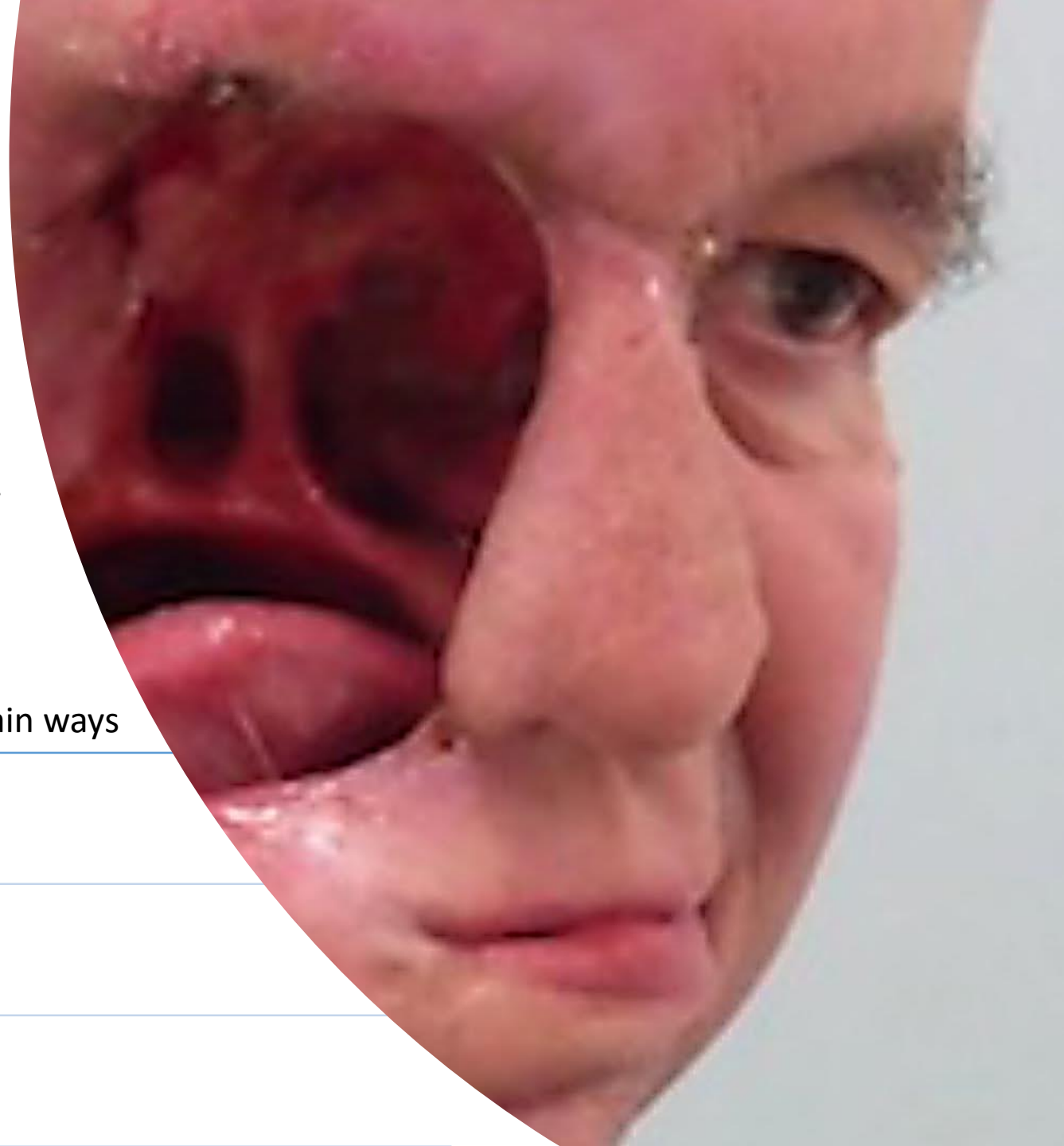
# B- Non-synonymous mutations

If a mutation leads to an **alteration** in the encoded **polypeptide**, it is known as *a **non-synonymous mutation.*** Alteration of the amino acid sequence of the protein product of a gene is likely to result in **abnormal function**.

## Types of Non-synonymous mutations

Non-synonymous mutations can occur in one of three main ways

| | |
|---|---|
| Non synonymous | Missense |
| | Nonsense |
| | Frameshift |

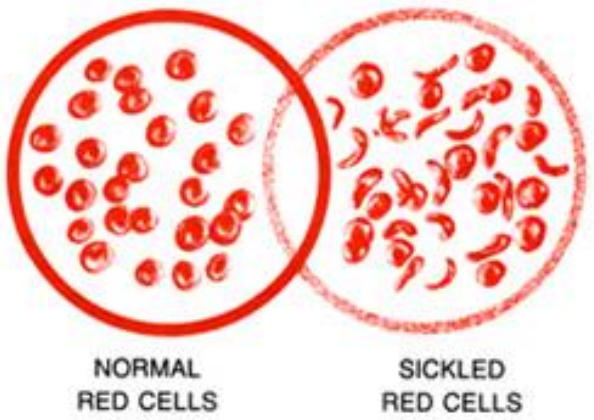


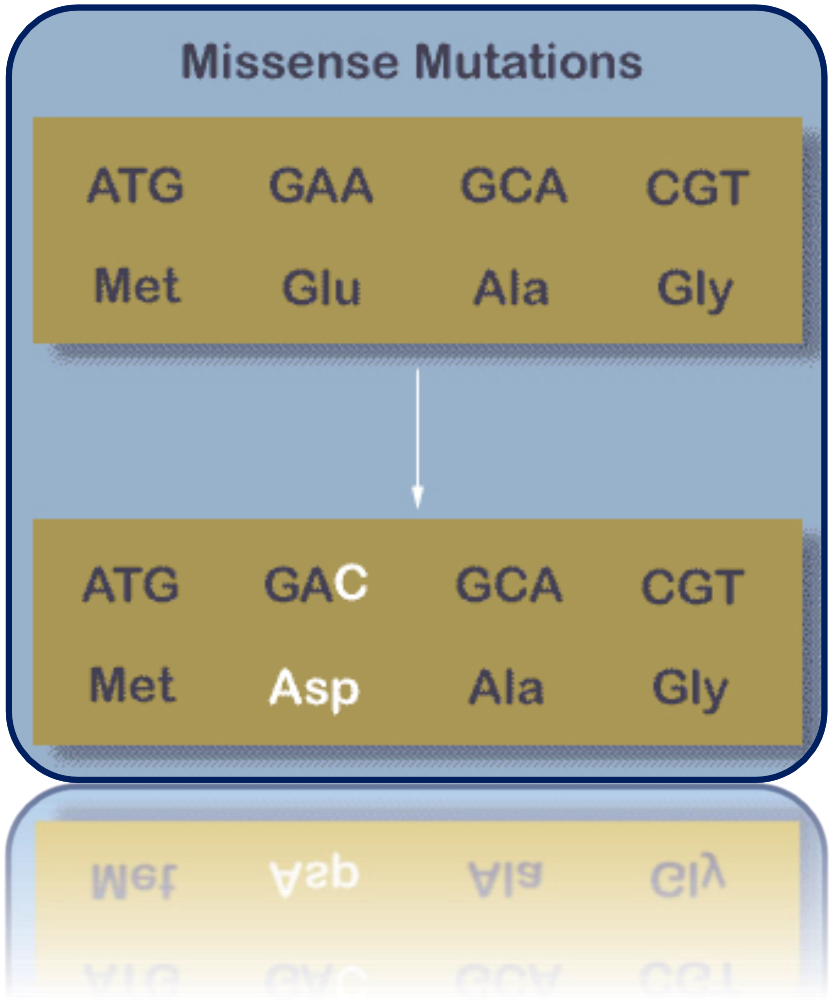
# 1- Missense mutation

- A **single bp substitution** that result in coding for a **different amino** acid
- This result in the synthesis of an **altered protein.**
- Missense mutations are the most common mutations observed in nature.

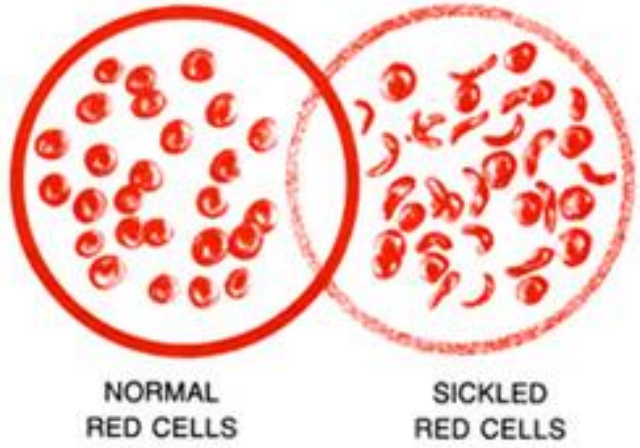
## Example of Missense Mutation → Sickle Cell Anaemia

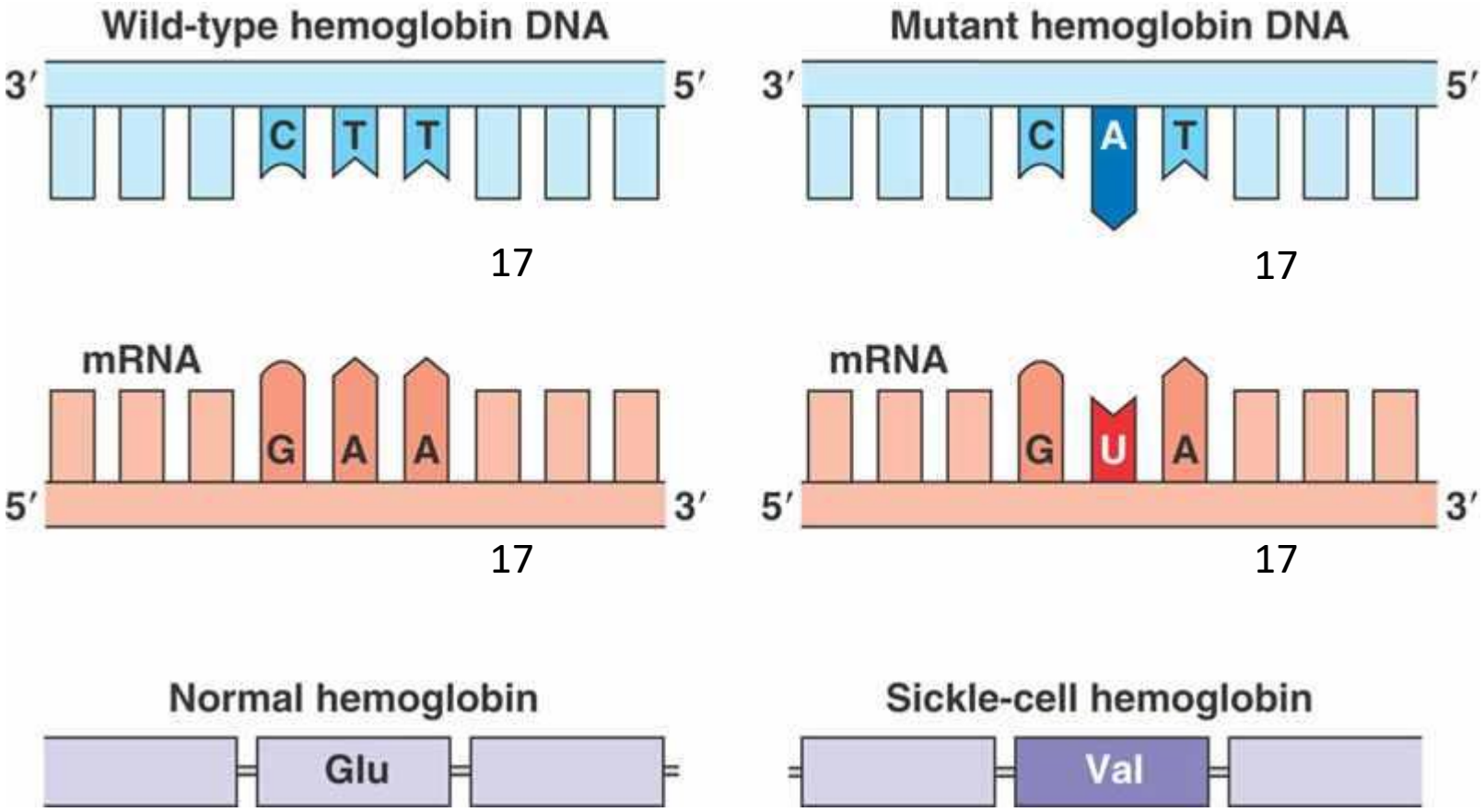
**Cause**: defective haemoglobin due to mutation in β-globin gene



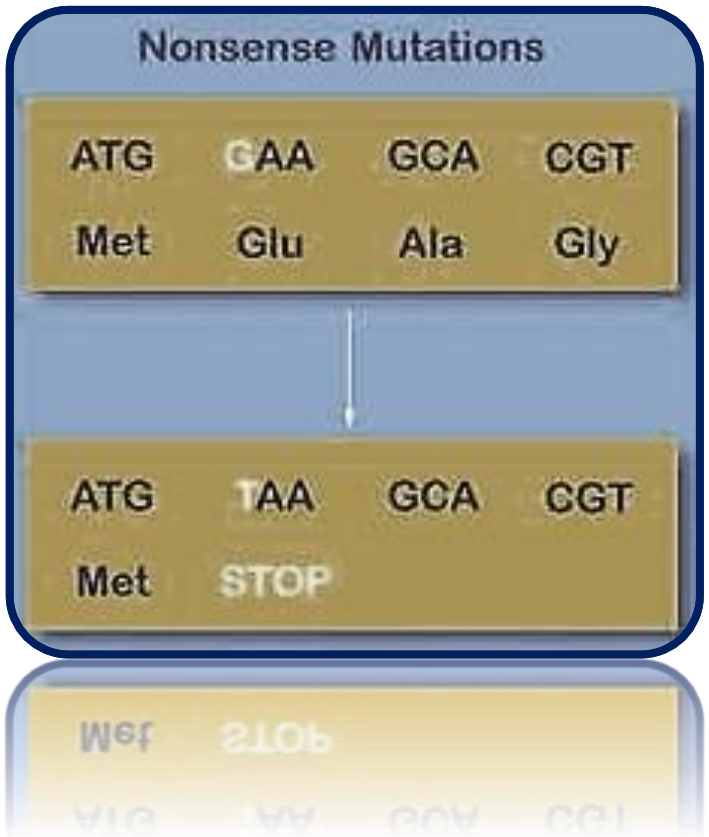
# Sickle Cell Anaemia



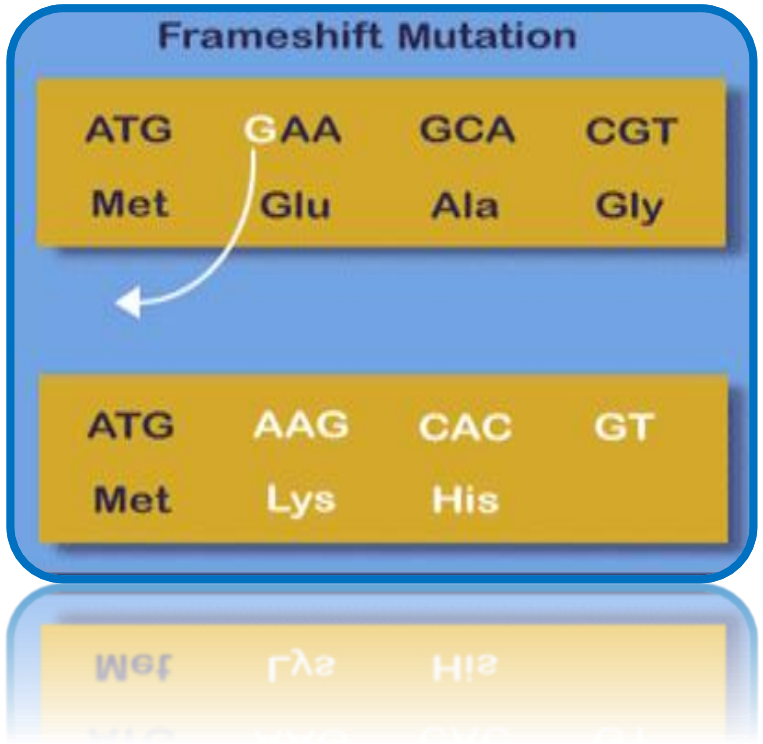
# 2- Nonsense Mutation

- A substitution which leads to the generation of one of the **stop codons.**
- **This** will result in **premature termination of translation of a peptide chain.**



# 3- Frameshift Mutations

If a mutation involves the **insertion** or **deletion** of nucleotides which are **not a multiple of three**, it will disrupt the **reading frame** and constitute what is known as a frameshift mutation.



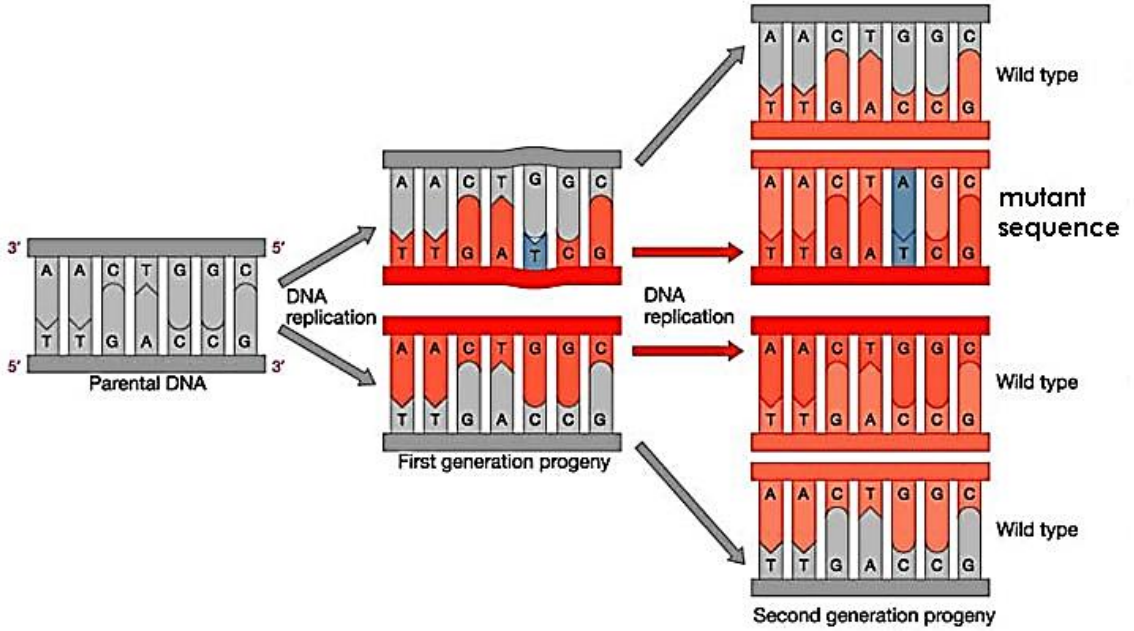
# Mutation Harmful vs. Helpful

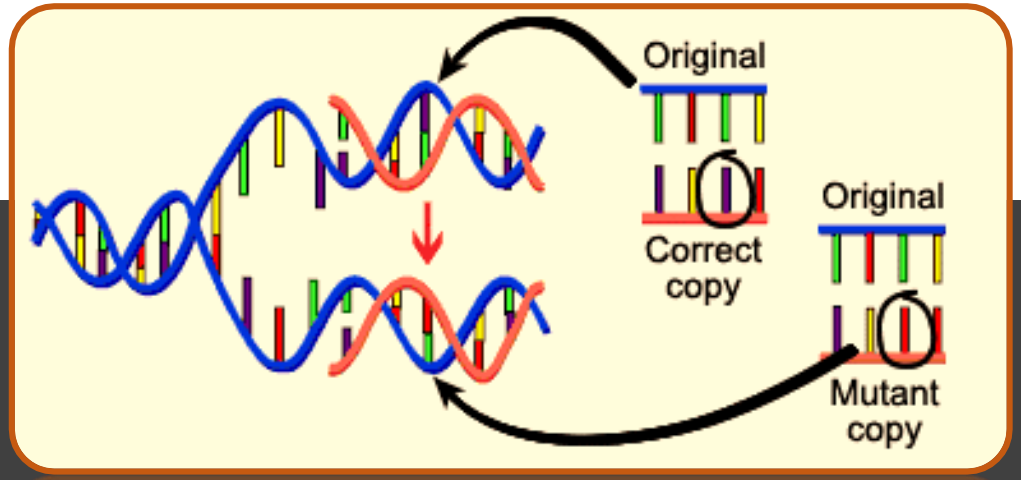
- **Mutations harmful**:
- -be bad, leading to cancer, aging, birth defects, self-aborted embryos

**Mutations helpful**:

- be good, making an organism survive better in its environment
- Example: bacteria becoming antibiotic-resistant
- The ability to drink milk as an adult is a helpful mutation (Lactose)

usually happens during DNA replication

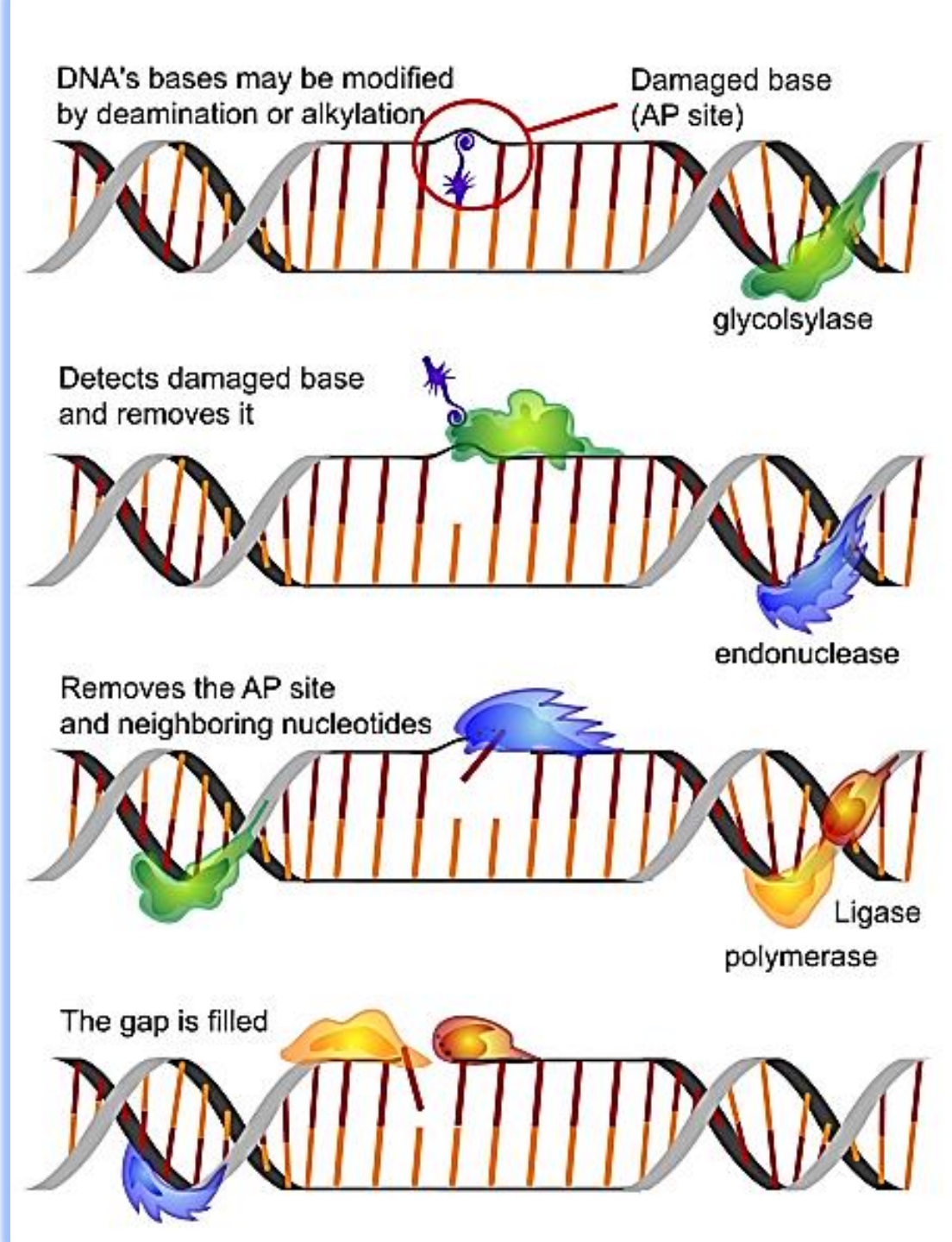



# When Mutations happen

# Mutation Repair

Note: Our DNA mutates all the time, but our cells have repair mechanisms. It is the overexposure to a mutagen that causes the worst problems, because the cell cannot repair all of it in time. Also, repair effectiveness reduces with age.



# What can cause a mutation?

- A mutation can be inherited, caused by environmental agents, or happen spontaneously
- Mutagen – anything environmental that can cause a change in DNA

## Mutagens

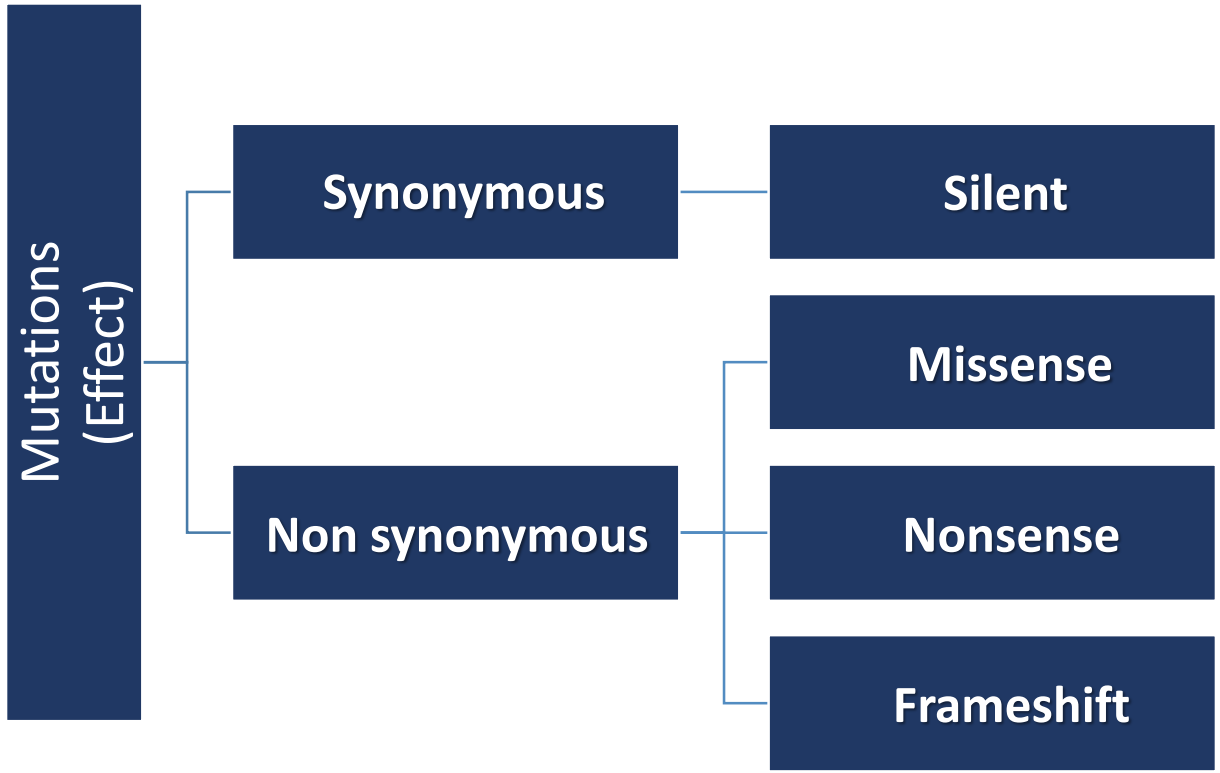
→Radiation – UV, X-rays, nuclear and wain

→Chemicals – asbestos, formaldehyde, chemicals in tobacco products

→(many mutagens are also carcinogens – cancer causing)

# Concept Check 2

## Effects of mutations on the protein




# Test your information

1. A mutation that changes a codon specifying an amino acid into a **stop codon** is called a:

A. missense mutation.
B. nonsense mutation.
C. frameshift mutation.
D. deletion mutation

# 2. A mutation that changes a codon specifying an amino acid into a **different amino acid** is called a:

A. missense mutation.
B. nonsense mutation.
C. synonymous mutation.
D. deletion mutation

# 3. A mutation that changes a codon into another codon specifying the same amino acid is called a:

A. missense mutation.
B. nonsense mutation.
C. synonymous mutation.
D. deletion mutation

# 4. Type of mutation caused by an addition or deletion of **one** base in the coding region:

A. missense mutation.
B. nonsense mutation.
C. synonymous mutation.
D. Frame-shift mutation

# 5. _____ Type of mutation in which a pyrimidine is substituted for a purine:

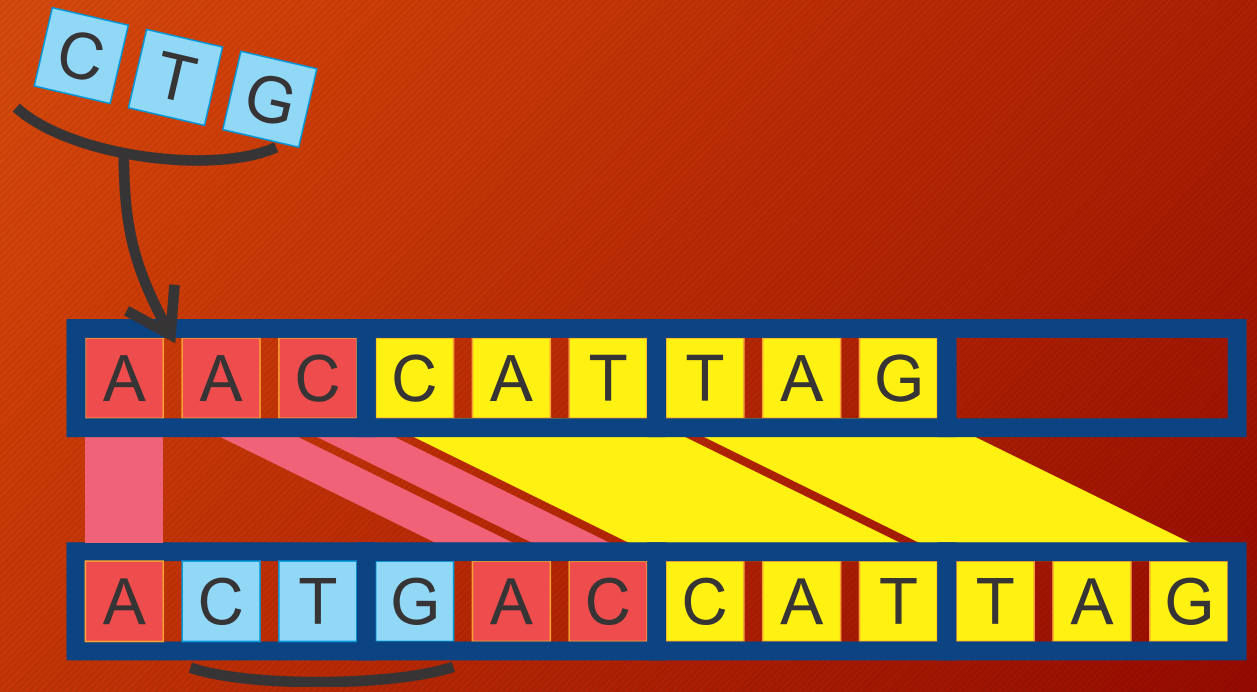
A. Transition
B. Transversion
C. Frameshift
D. Conversion
E. Inversion

# 6. _____ Type of mutation in which a purine is substituted for a purine :

A. Transition
B. Transversion
C. Frameshift
D. Conversion
E. Inversion

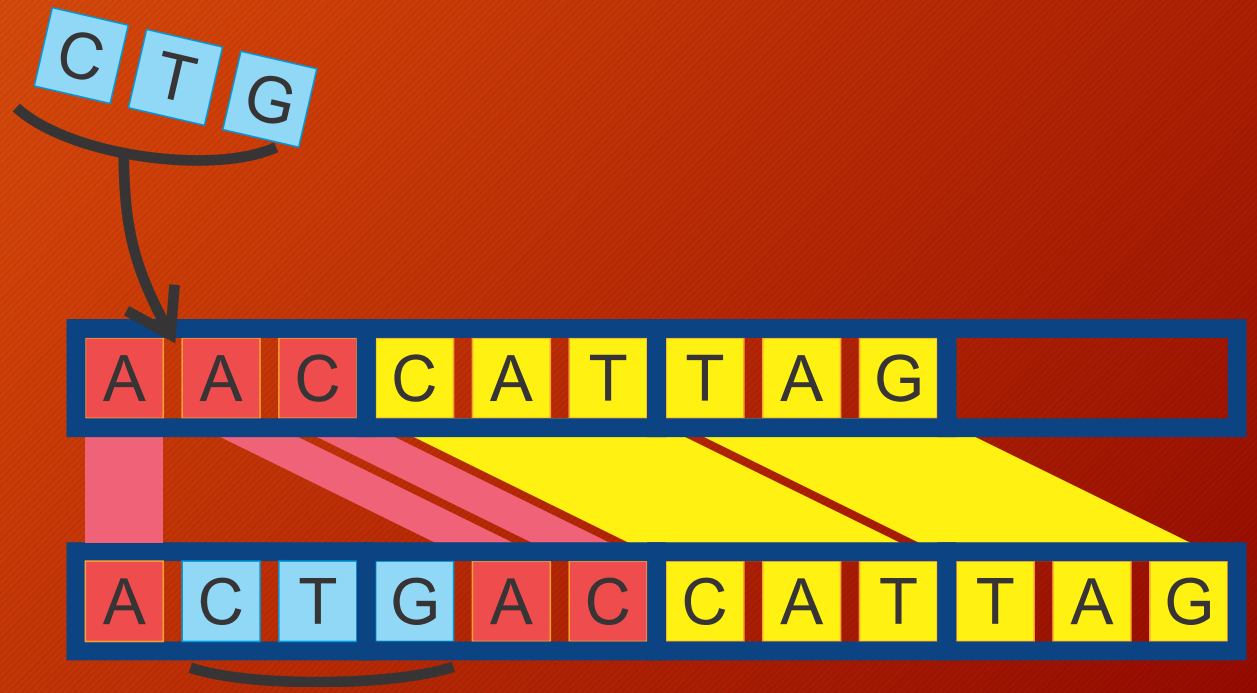
# 7. Study the figure and answer:
# I. What is the type of mutation?

A. Insertion
B. Deletion
C. Substitution



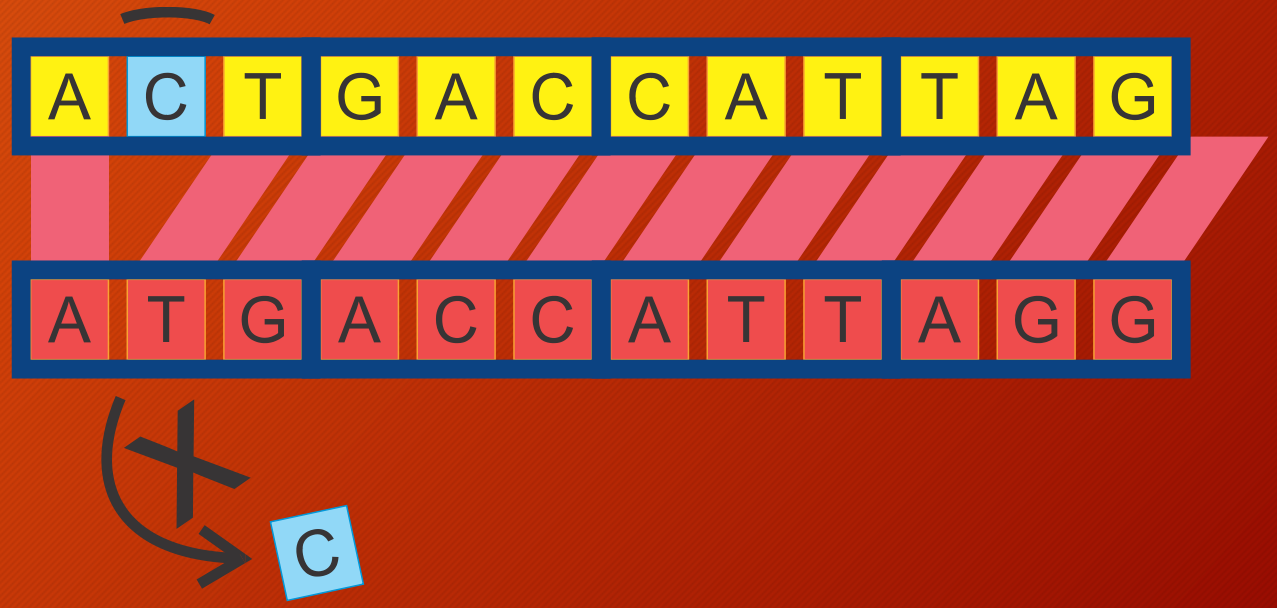
# 8 II. Did this mutation produce a frame-shift?

A. Yes
B. No



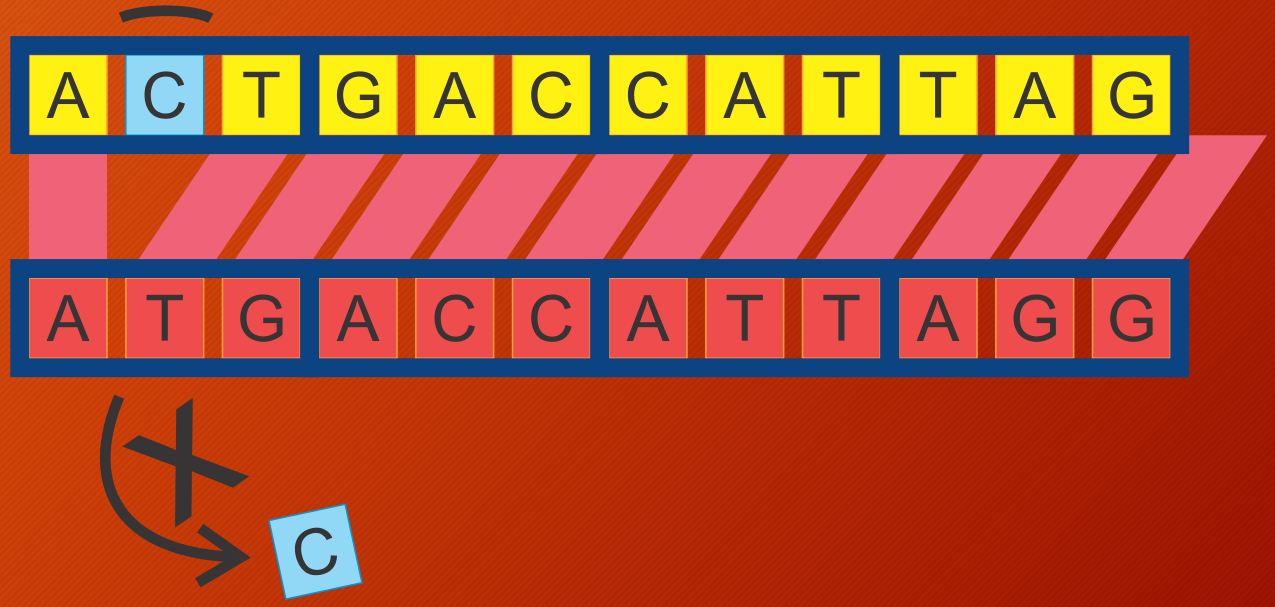
# 9. Study the figure and answer: What is the type of mutation

A. Insertion
B. Deletion
C. Substitution



# 10. Did this mutation produce a frame-shift?

A. Yes
B. No



# End of Lecture
# Good Luck!

See you

in next lecture...

Greetings of

**DoctorQari**


End Lecture 9