

INTRODUCTION TO DNA & PROTEIN SYNTHESIS

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Objectives

At the end of this lecture the student should be able to understand ,

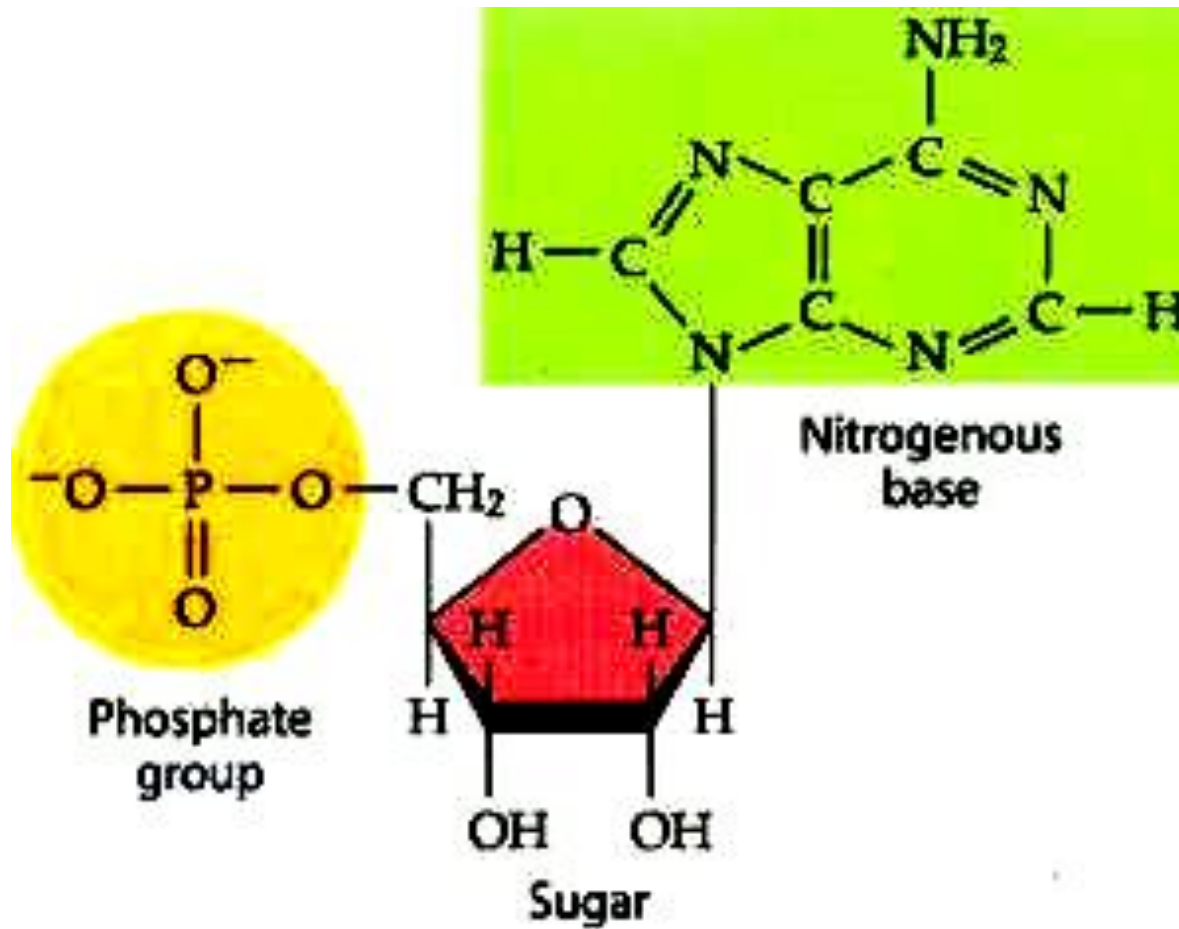
- The structure of the DNA
- The structure of the RNA
- Steps in protein synthesis

BUILDING BLOCKS OF DNA

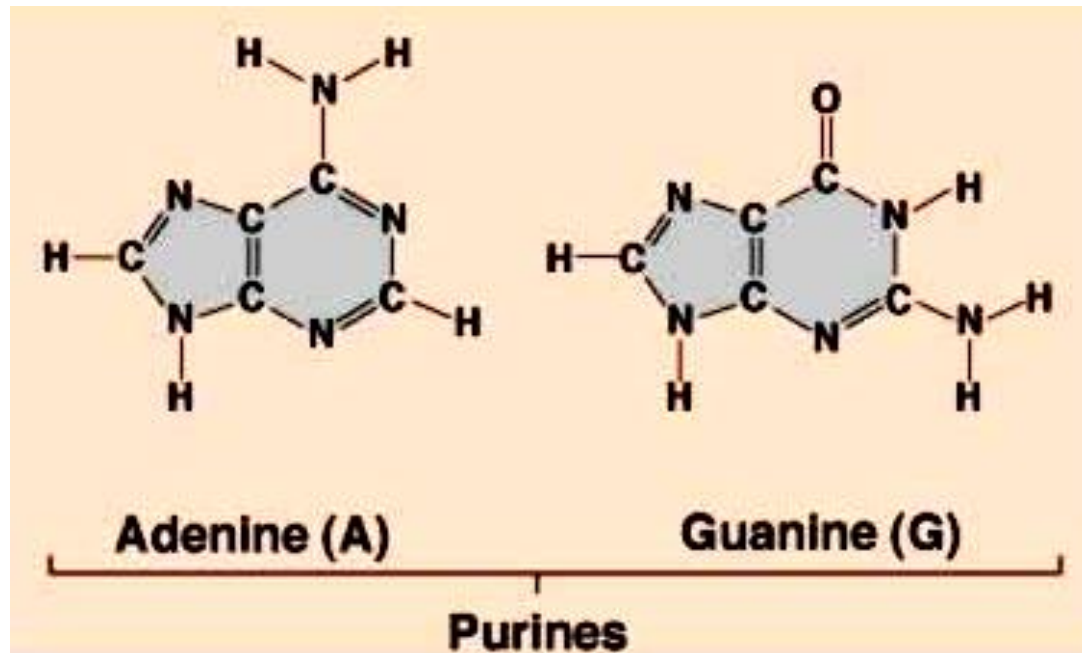
Composed of nucleotides

- Nucleotides contain three parts:
 1. **5-Carbon Sugar** (deoxyribose)
 2. **Phosphate Group**
 3. **Nitrogen Base** (four types, adenine, guanine, thymine and cytosine)

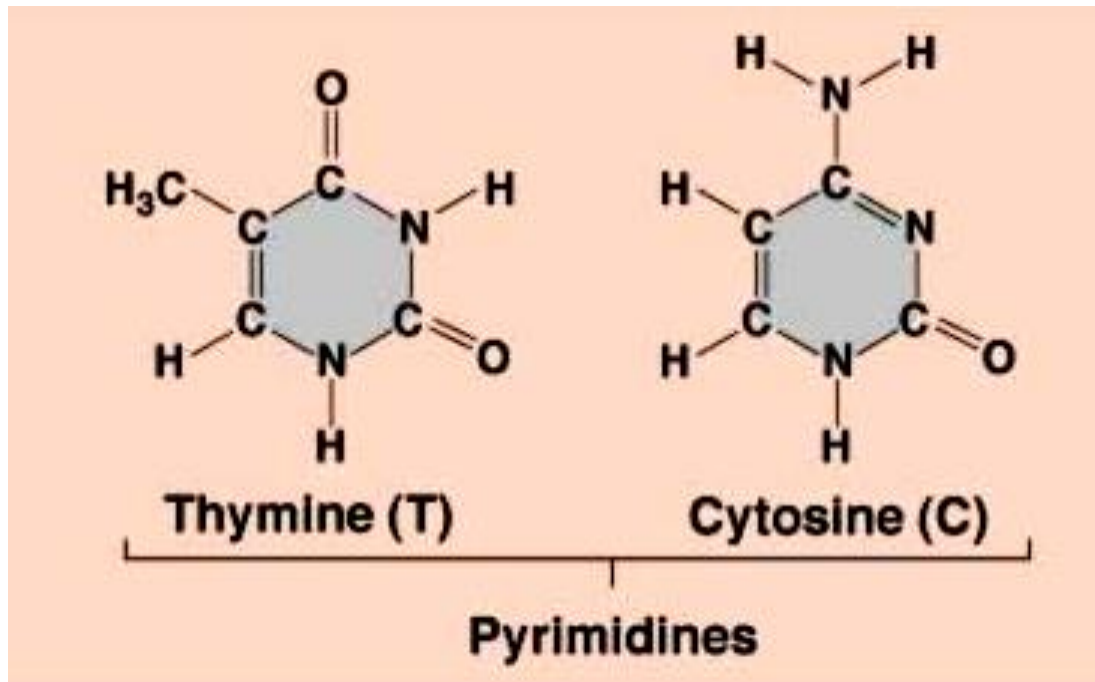
Structure of the DNA



- Adenine and Guanine are purines
(composed of two rings of nitrogen atoms)



- Thymine and Cytosine are pyrimidines
(composed of one ring of nitrogen atoms)



STRUCTURE OF DNA

- Consists of two strands of nucleotides that form a twisted ladder (double helix)
- Sugar and phosphate alternate along the sides of the ladder (linked by strong covalent bonds)
- Pairs of nitrogen bases form the rungs of the ladder (linked by weak hydrogen bonds).

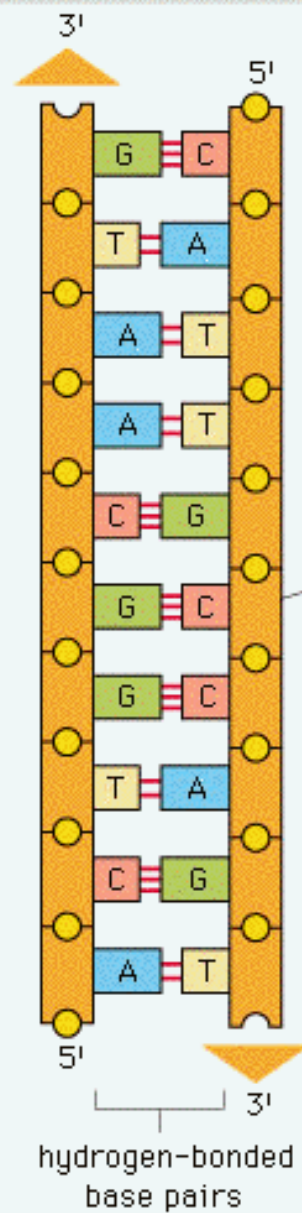
- Specific base pairing arrangement (Chargaff's Rule)

A-T : 2 hydrogen bonds

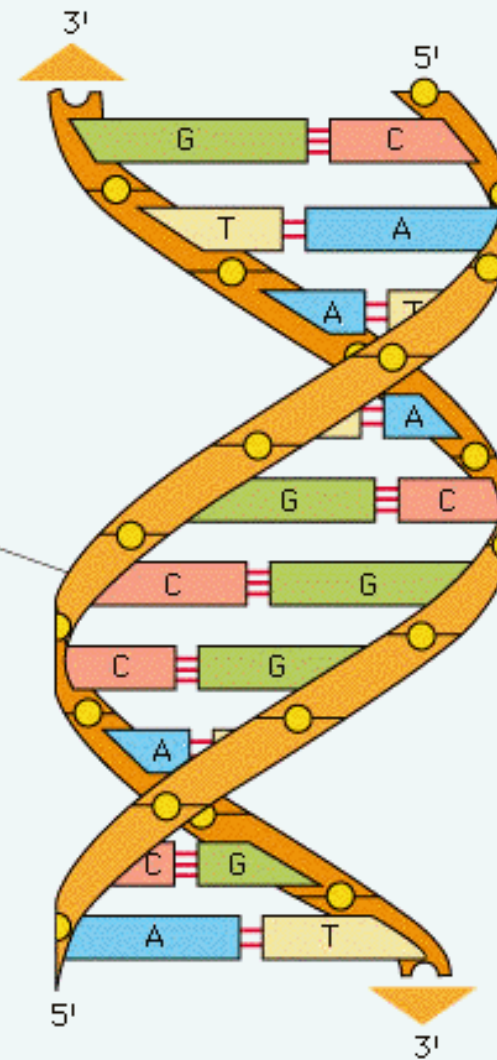
C-G : 3 hydrogen bonds

- Strands run in opposite directions

double-stranded DNA



DNA double helix



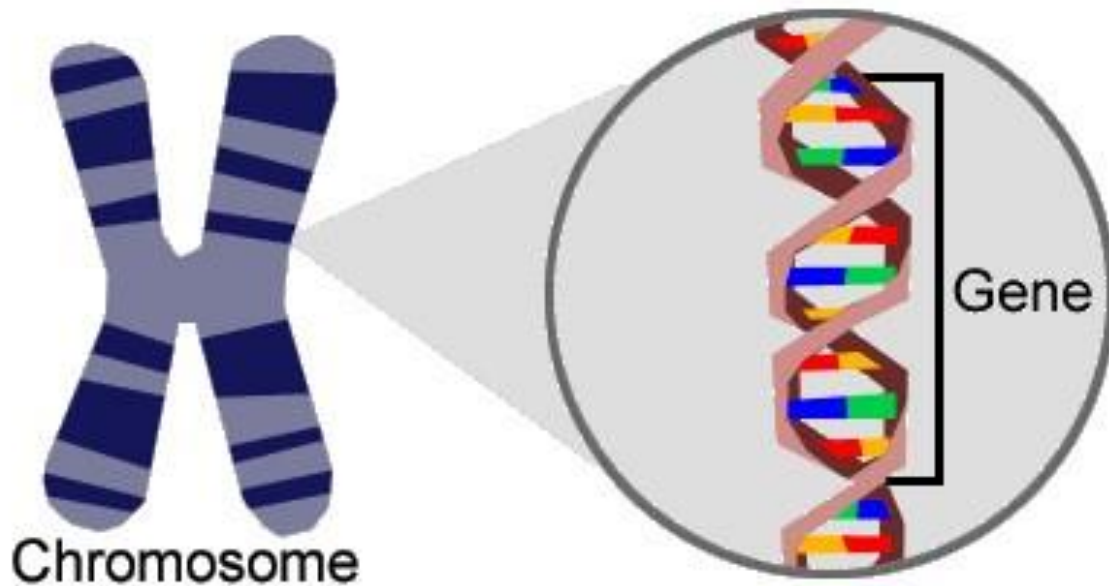
sugar-phosphate
backbone

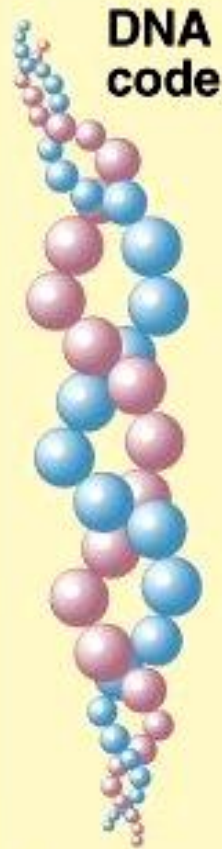
Relationship between DNA and protein synthesis

- DNA codes for proteins (structural proteins, enzymes, and hormones)
- information for building proteins is carried in the sequence of nitrogen bases

- Sections of DNA on the chromosome that code for proteins are called genes.

The Relationship Between Chromosomes and Genes





One gene is a
segment of DNA
that codes for
one protein



Structural
proteins



Enzymatic
proteins



Hormonal
proteins

**Metabolic
translation
process**

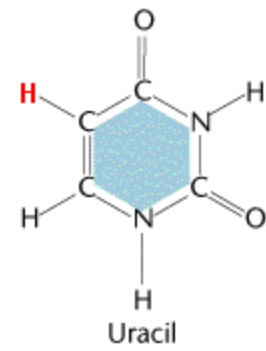
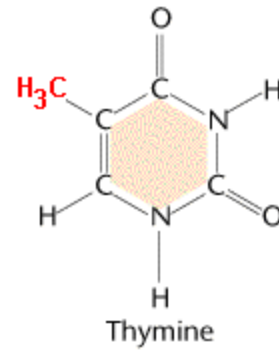
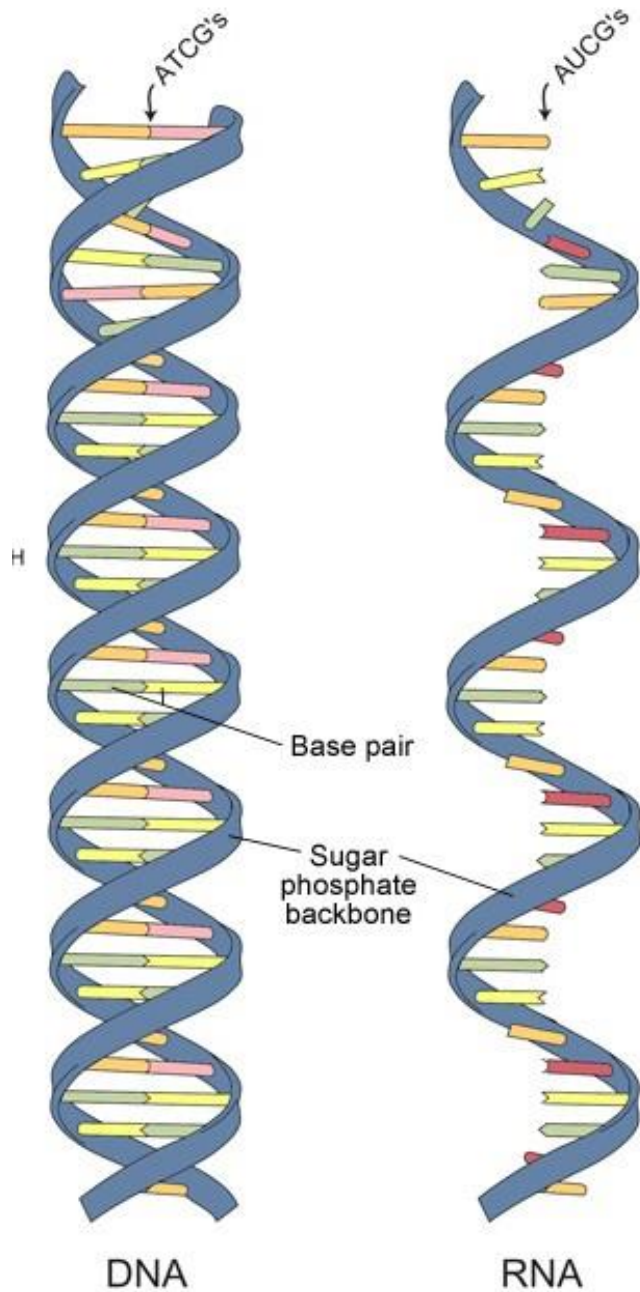
RNA (RIBONUCLEIC ACID)

Nucleic acid involved in the synthesis
of proteins

RNA STRUCTURE

Composed of nucleotides, but differs from DNA in three ways.

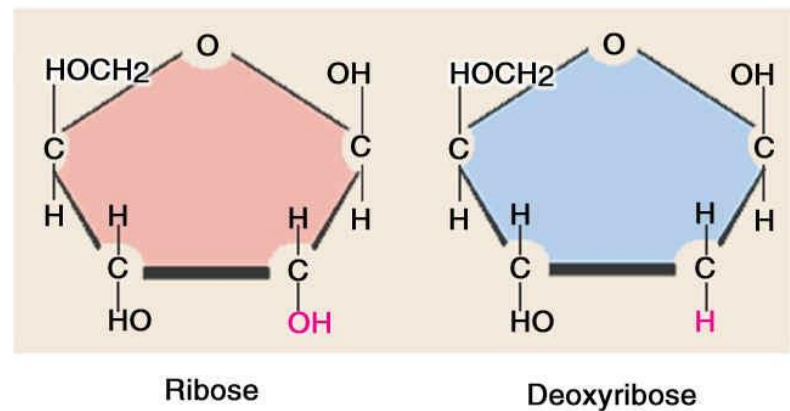
1. Single strand of nucleotides instead of double stranded
2. Has uracil instead of thymine
3. Contains ribose instead of deoxyribose



(Klug & Cummings 1997)

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Ribose and Deoxyribose

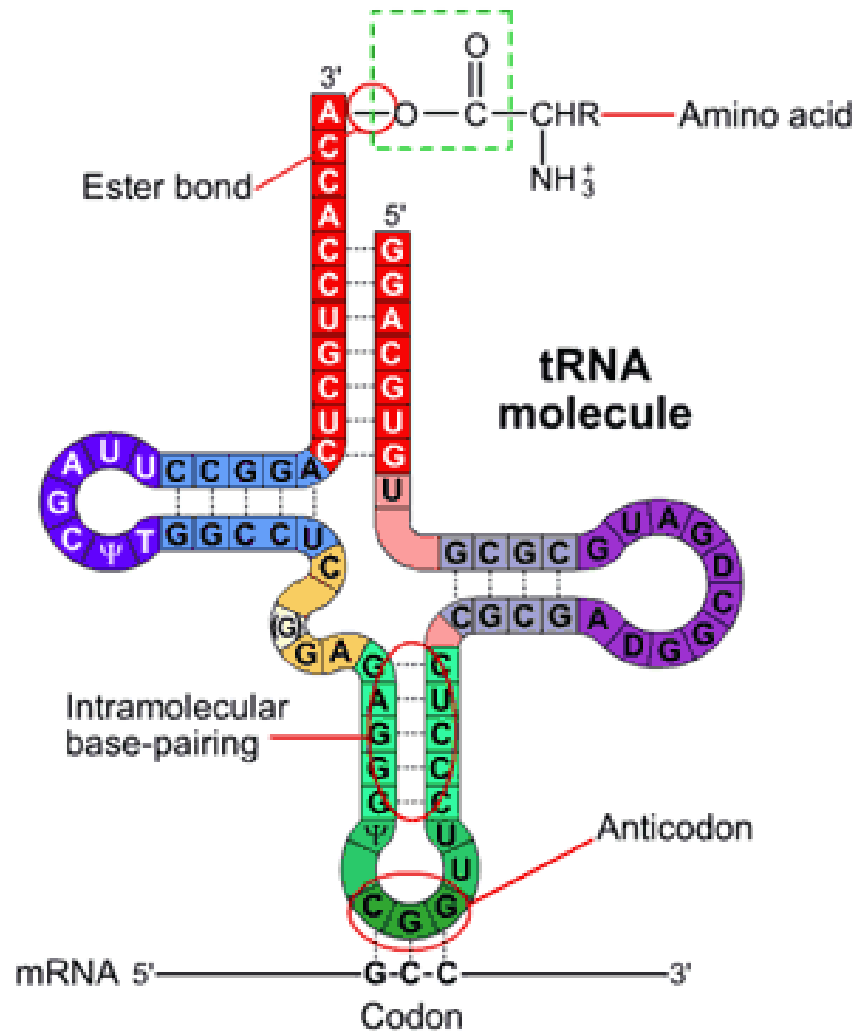


RNA FUNCTION

Three forms of RNA involved in protein synthesis

1. **mRNA (messenger)**: copies instructions in DNA and carries these to the ribosome.
2. **tRNA (transfer)**: carries amino acids to the ribosome.
3. **rRNA (ribosomal)**: composes the ribosome.

tRNA structure



PROTEIN SYNTHESIS

Cells build proteins following instructions coded in genes (DNA).

- Consists of two steps,

1. Transcription

2. Translation

TRANSCRIPTION

DNA is copied into a complementary strand of mRNA.

WHY?

- DNA cannot leave the nucleus. Proteins are made in the cytoplasm. mRNA serves as a “messenger” and carries the protein building instructions to the ribosomes in the cytoplasm.

LOCATION OF TRANSCRIPTION-

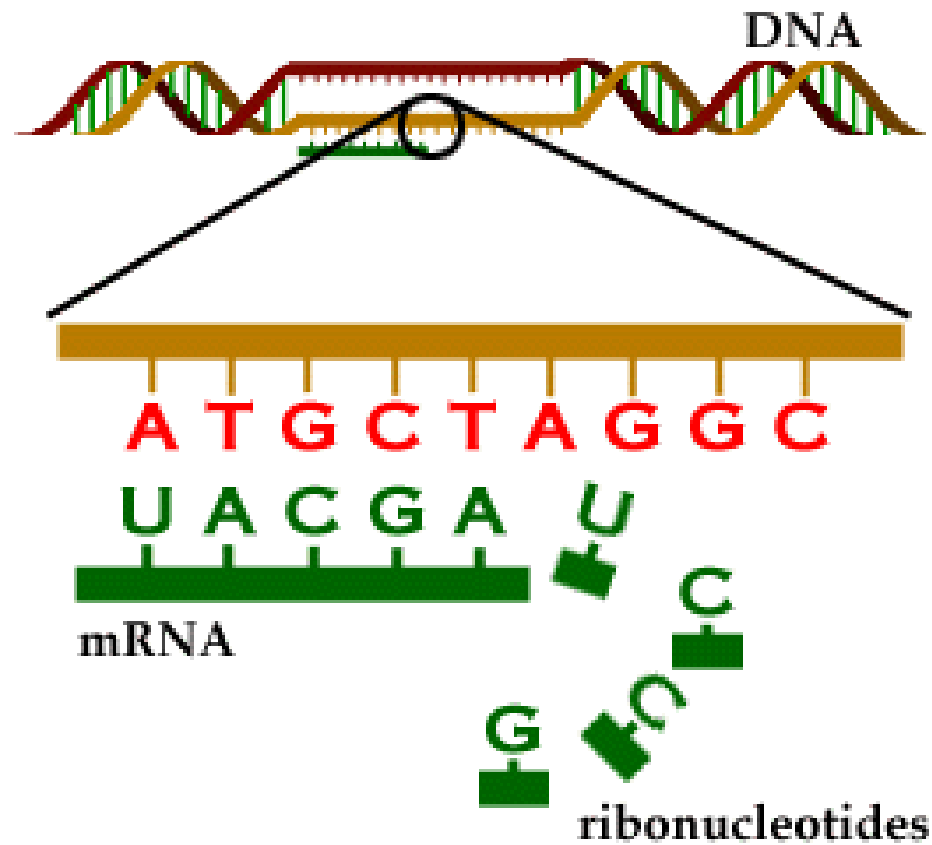
Nucleus

HOW TRANSCRIPTION OCCURS

1. **RNA polymerase** untwists and unzips a section of DNA (usually a single gene)
2. **RNA polymerase** pairs free RNA nucleotides to the exposed bases of one of the DNA strands following base pair rules.
 - Uracil replaces thymine
 - Only 1 strand of DNA serves as a template, the other “hangs out”

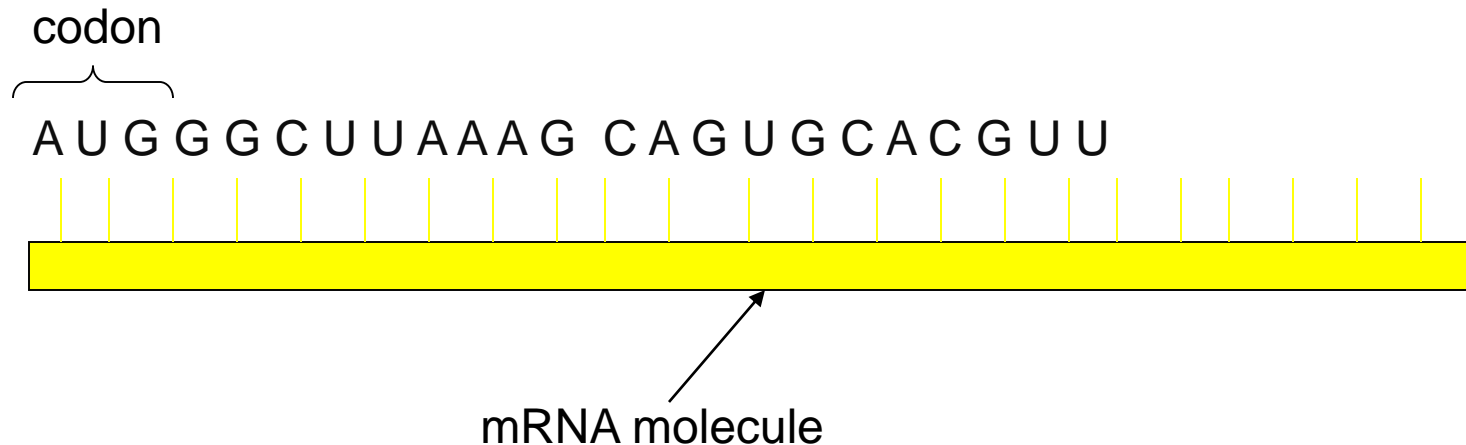
3. Newly synthesized mRNA separates from template DNA and DNA zips back up.

Transcription



RESULT OF TRANSCRIPTION

mRNA strand with instructions for building a protein that leaves the nucleus and goes to the cytoplasm.



EXAMPLE FOR TRANSCRIPTION-

- Transcribe the following DNA Sequence in mRNA

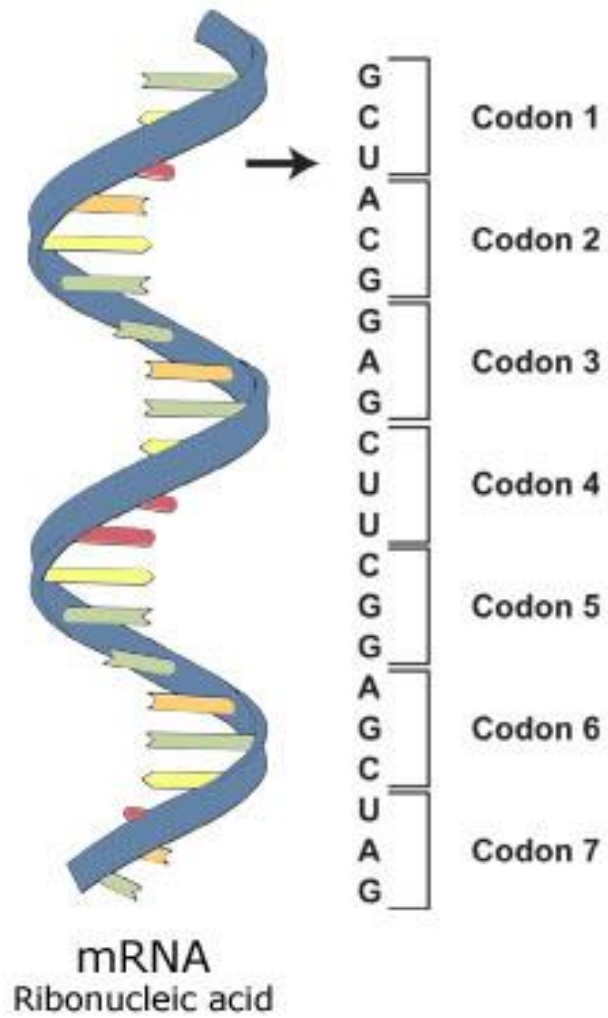
DNA TAC CGG ATC CTA GGA TCA

mRNA AUG GCC UAG GAU CCU AGU

GENETIC CODE

The “language” that translates the sequence of nitrogen bases in DNA (mRNA) into the amino acids of a protein.

- Codon = three nucleotides on DNA or mRNA
- One codon specifies one amino acid
- Some codons are redundant (code for the same amino acid)
- The genetic code is universal to all organisms



TRANSLATION

Instructions in mRNA are used to build a protein

LOCATION OF TRANSLATION

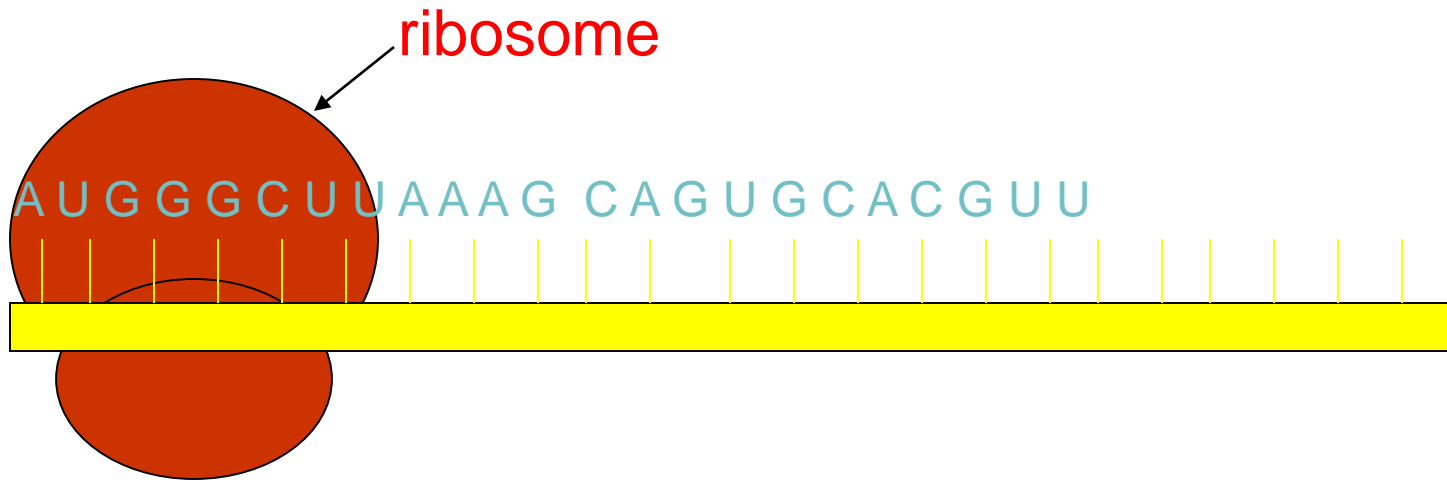
ribosome (in the cytoplasm)

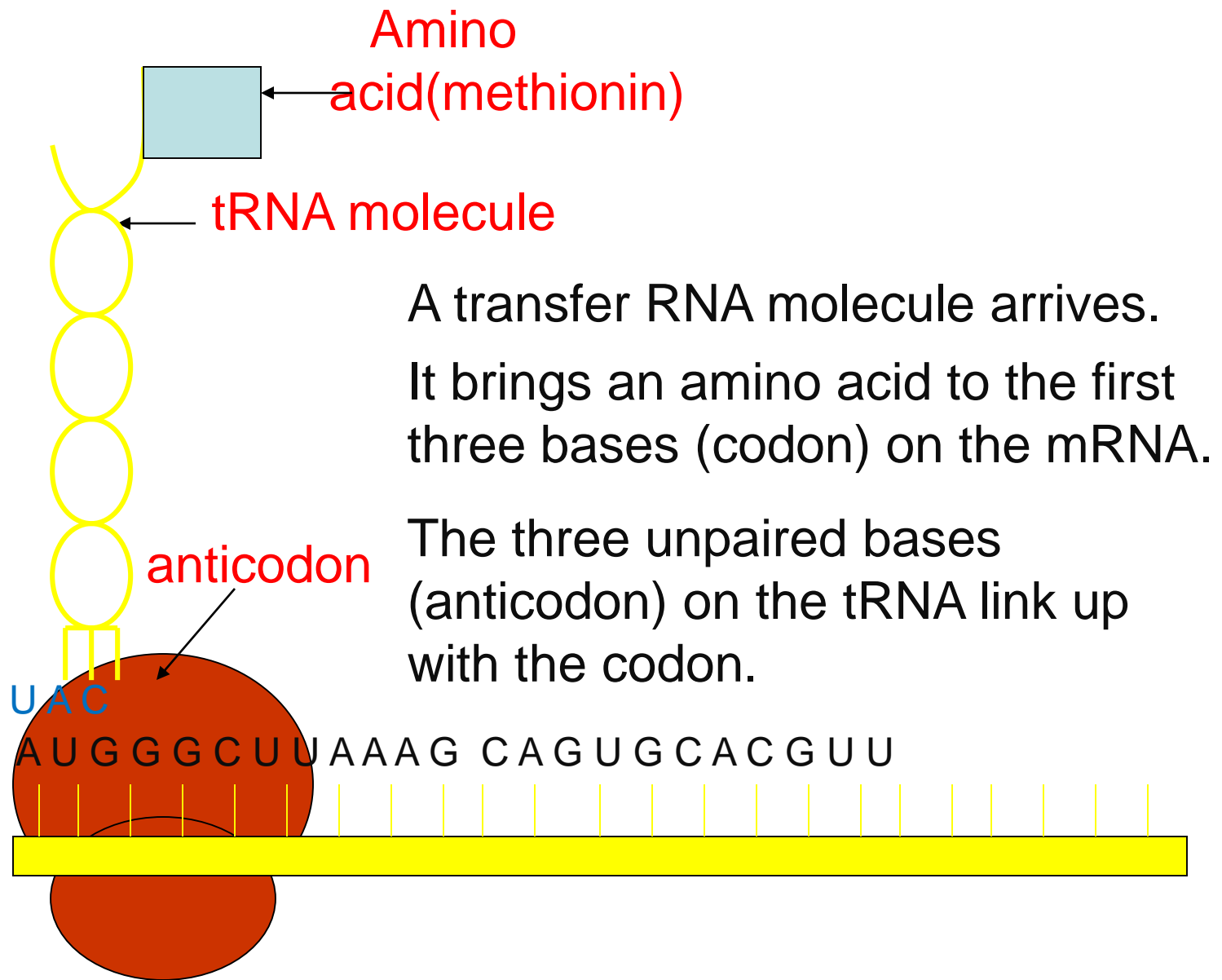
PROCESS OF TRANSLATION

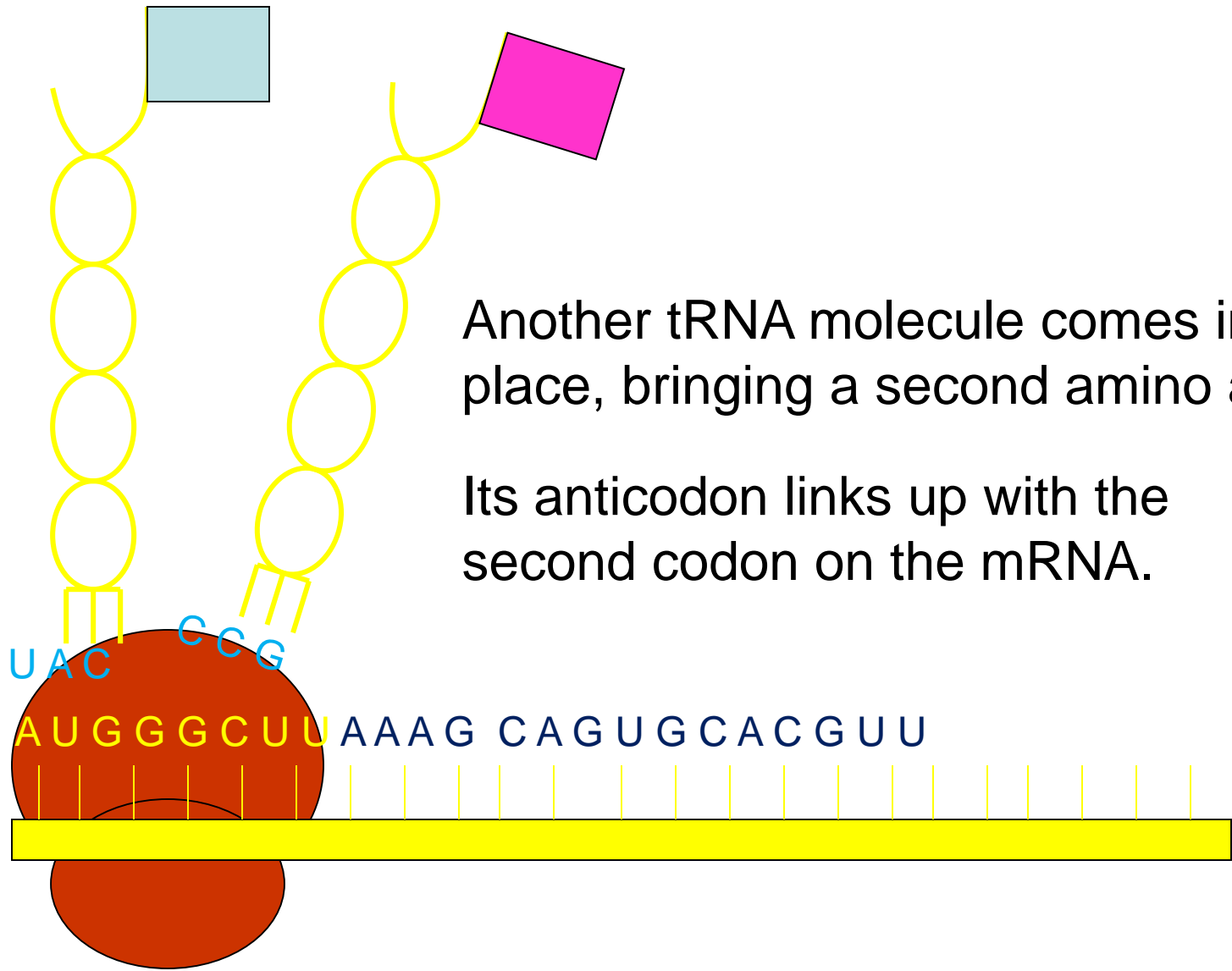
Occurs in three steps,

- **1.Initiation**-AUG codon in mRNA starts translation ,Methionine is the 1st amino acid taken by the tRNA.
- **2.elongation**-lengthen the peptide chain
- **3.Termination**-UAA, UAG, UGA codons in the mRNA stop translation.

A ribosome on the rough endoplasmic reticulum attaches to the mRNA molecule.

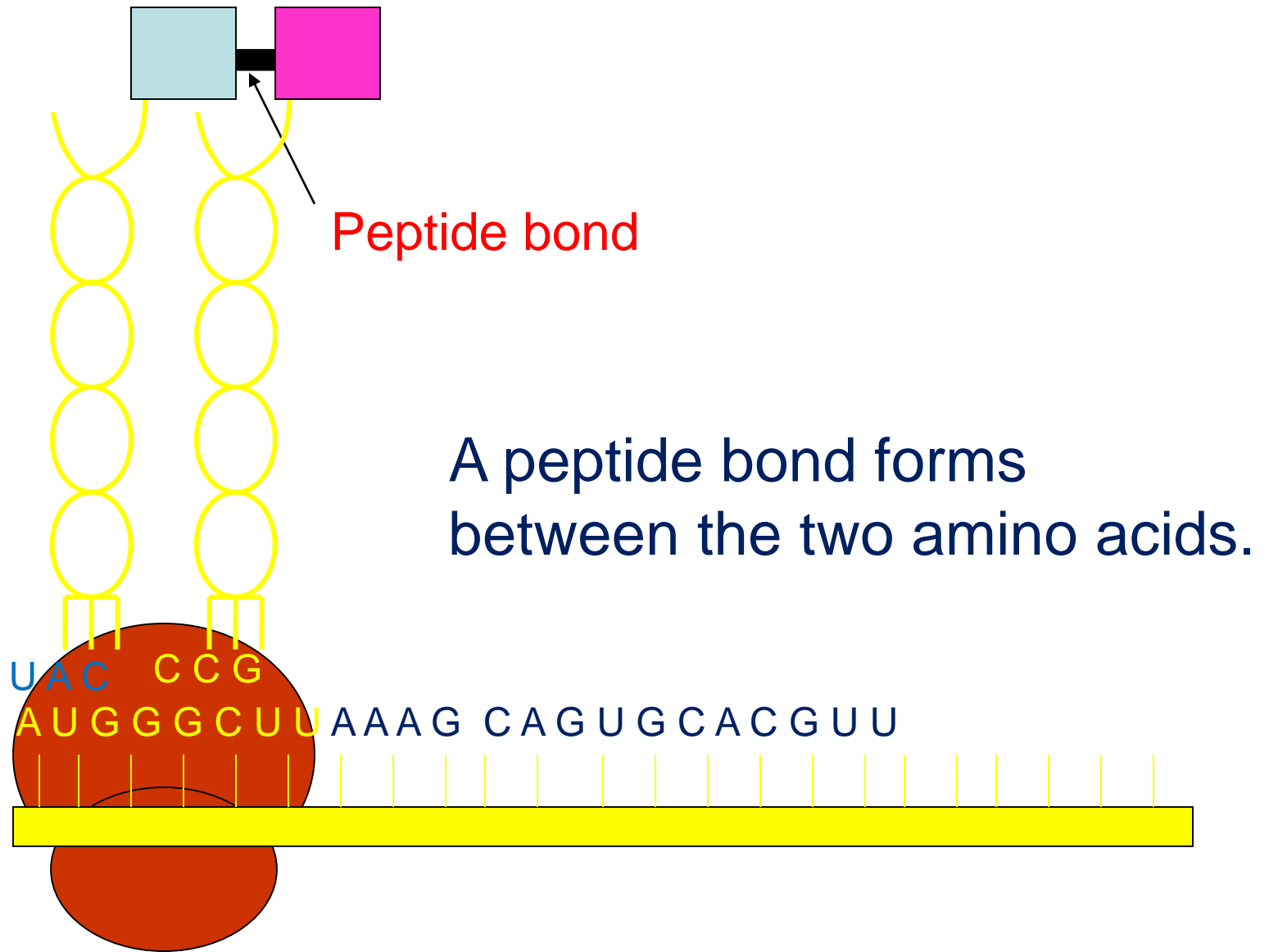


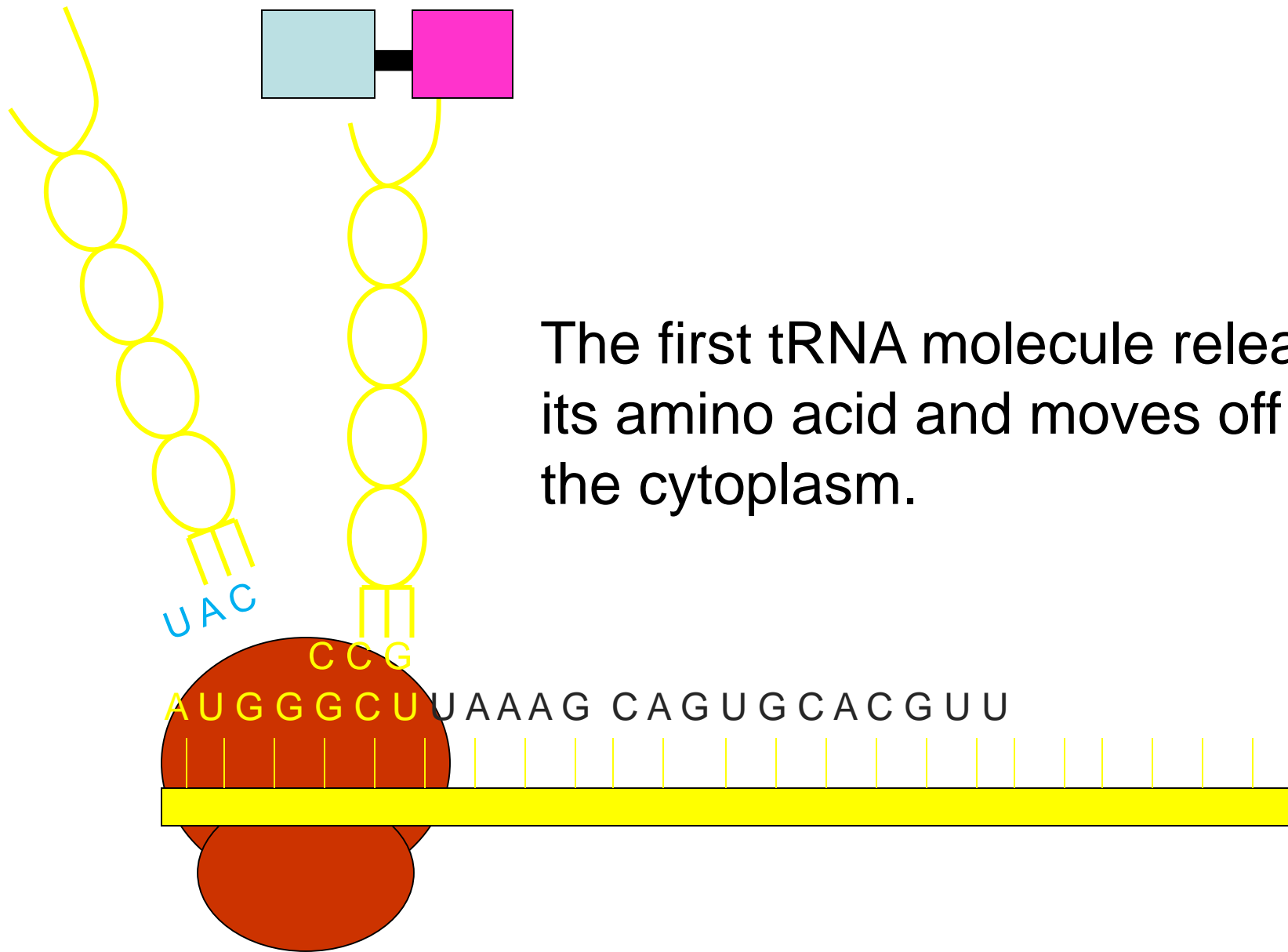




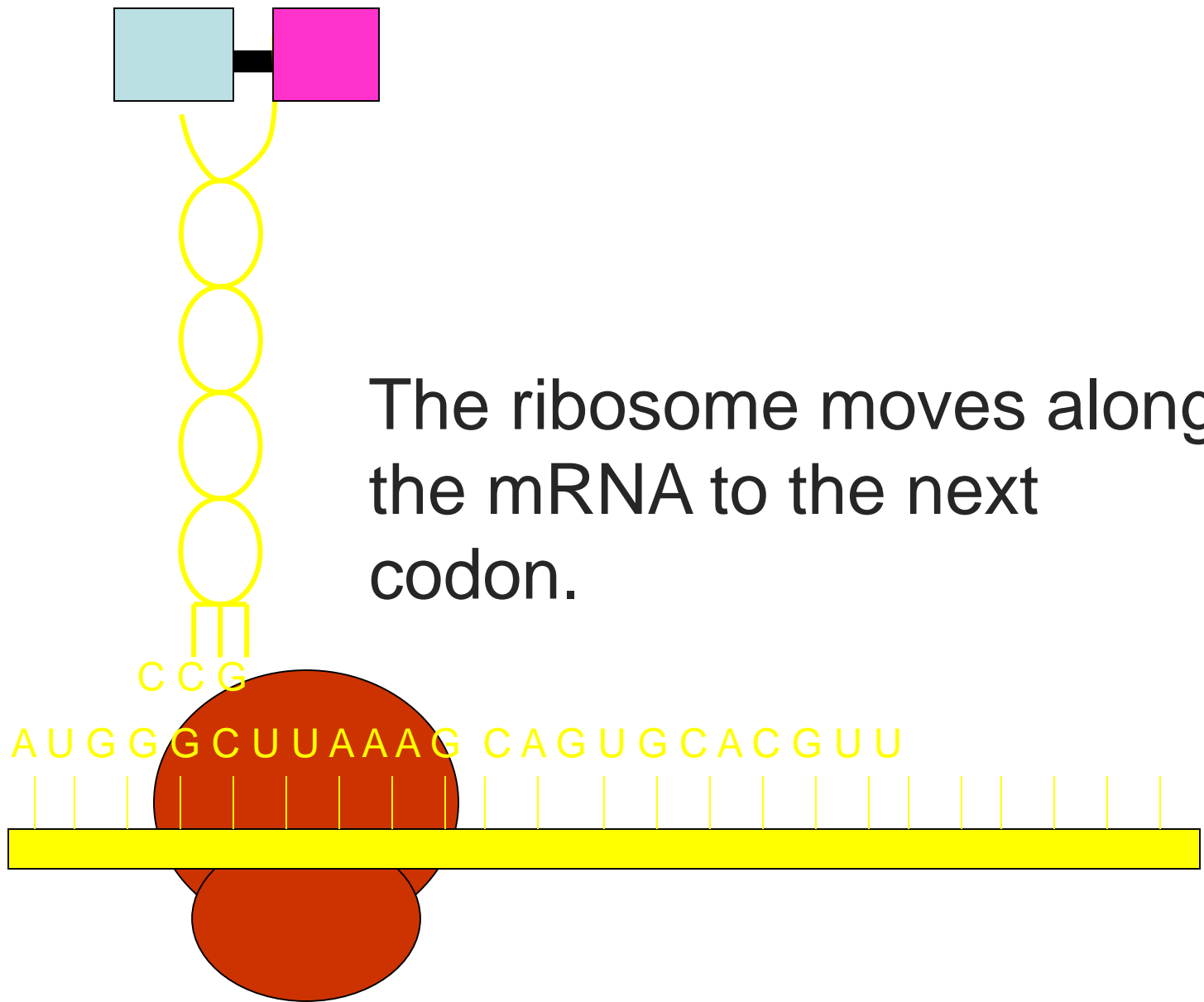
Another tRNA molecule comes into place, bringing a second amino acid.

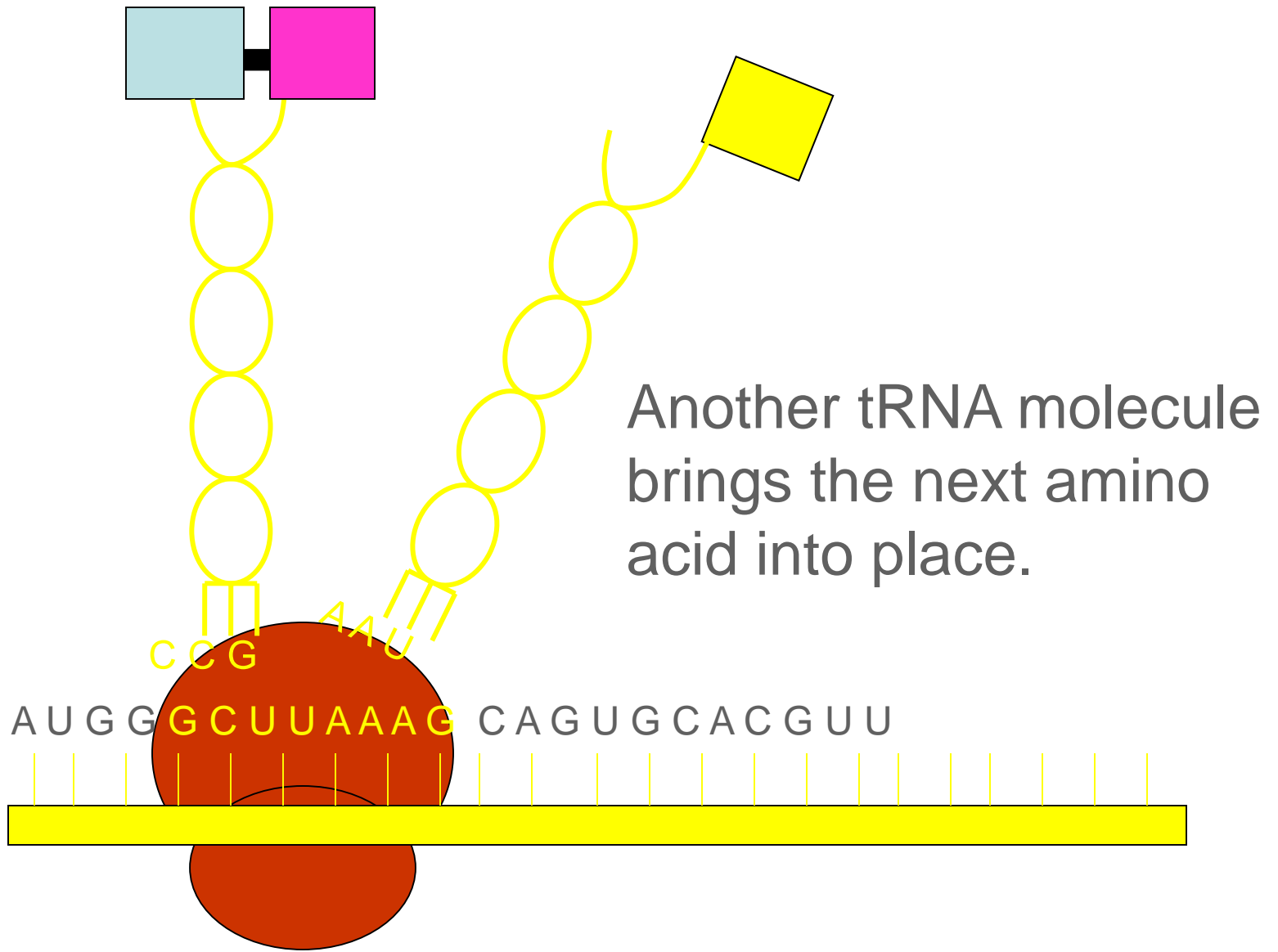
Its anticodon links up with the second codon on the mRNA.

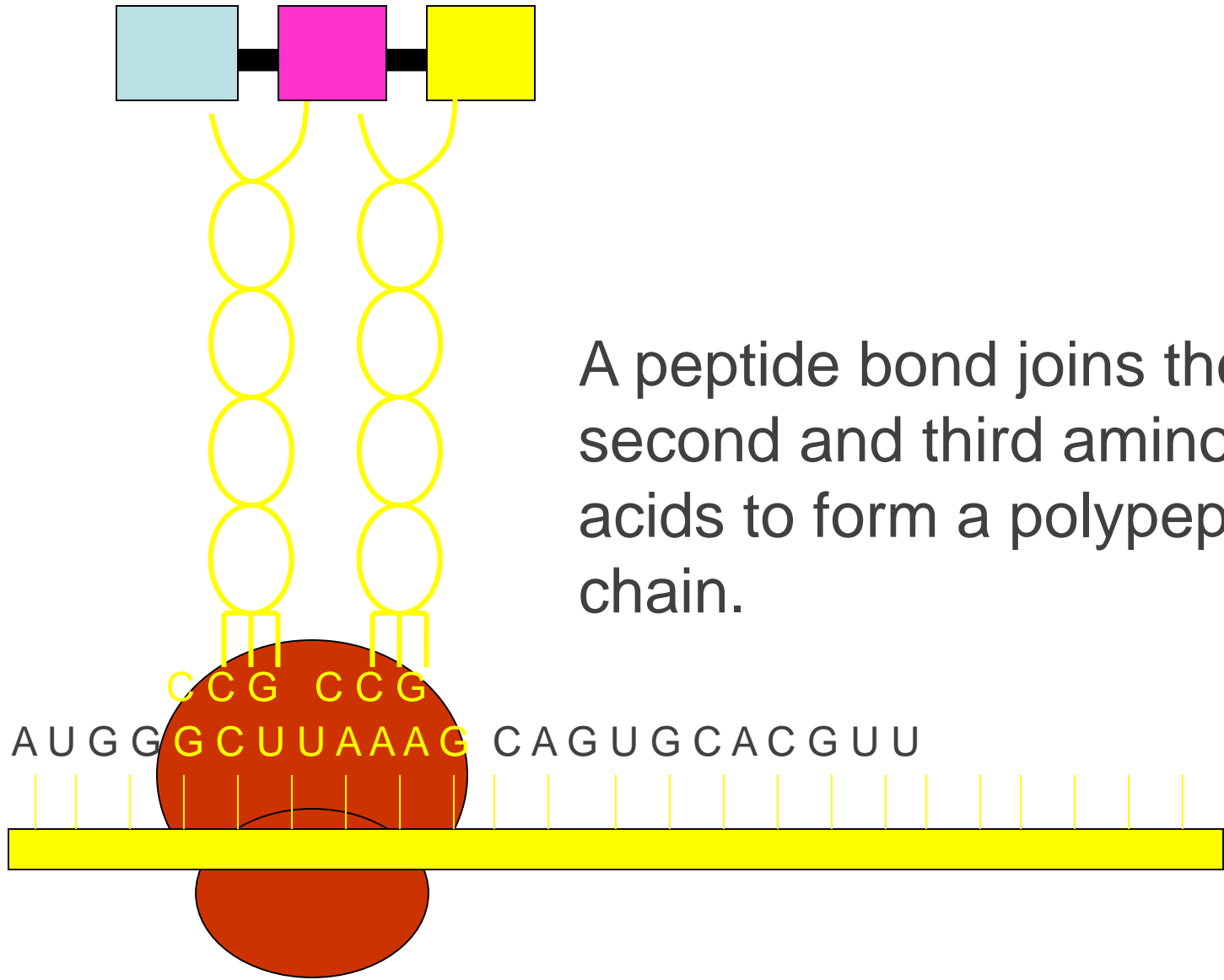




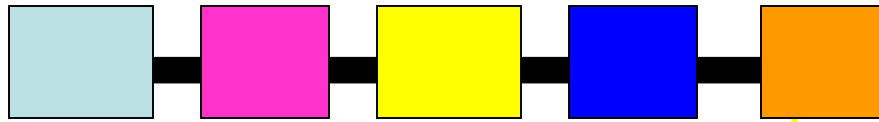
The first tRNA molecule releases its amino acid and moves off into the cytoplasm.







A peptide bond joins the second and third amino acids to form a polypeptide chain.

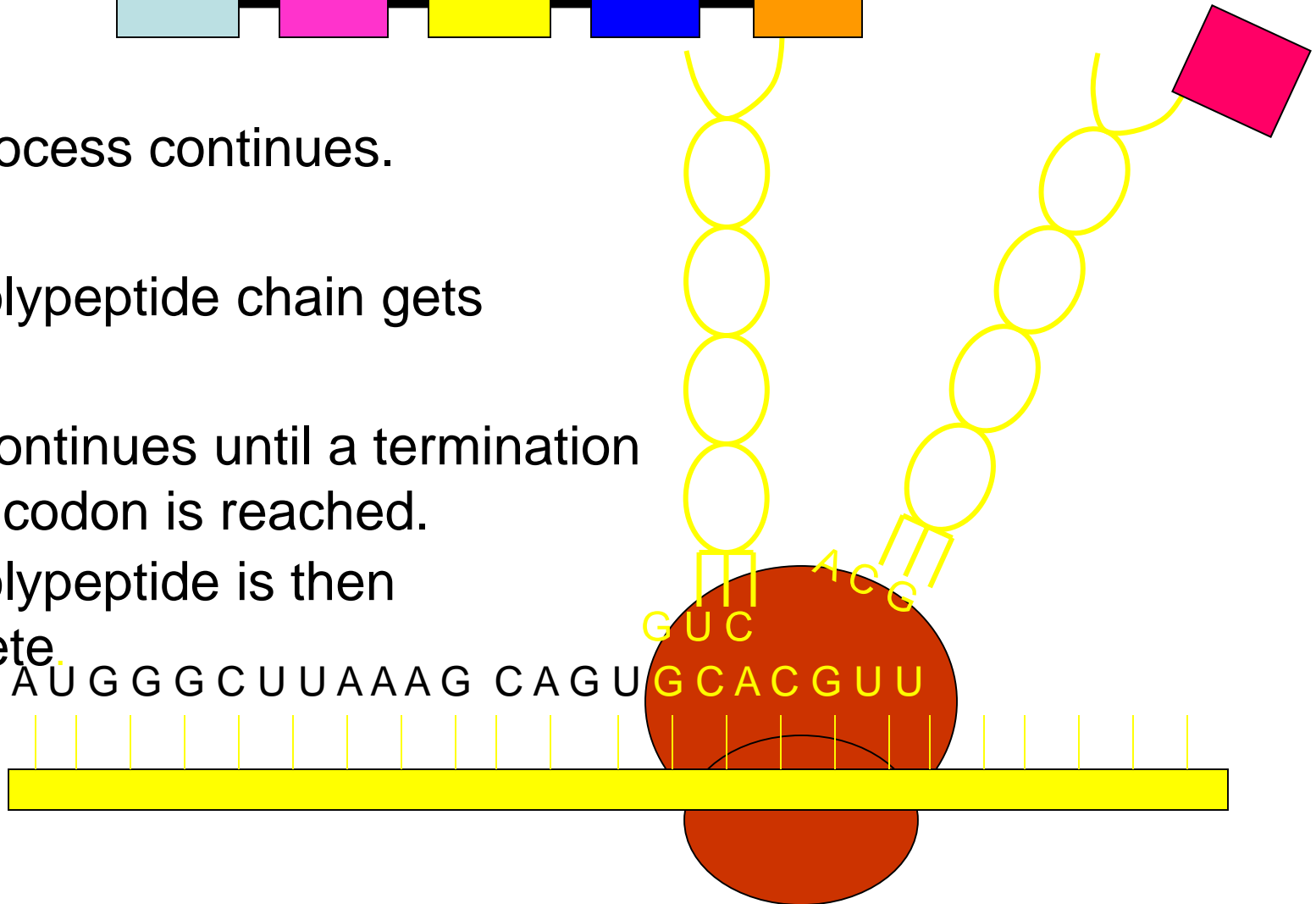


The process continues.

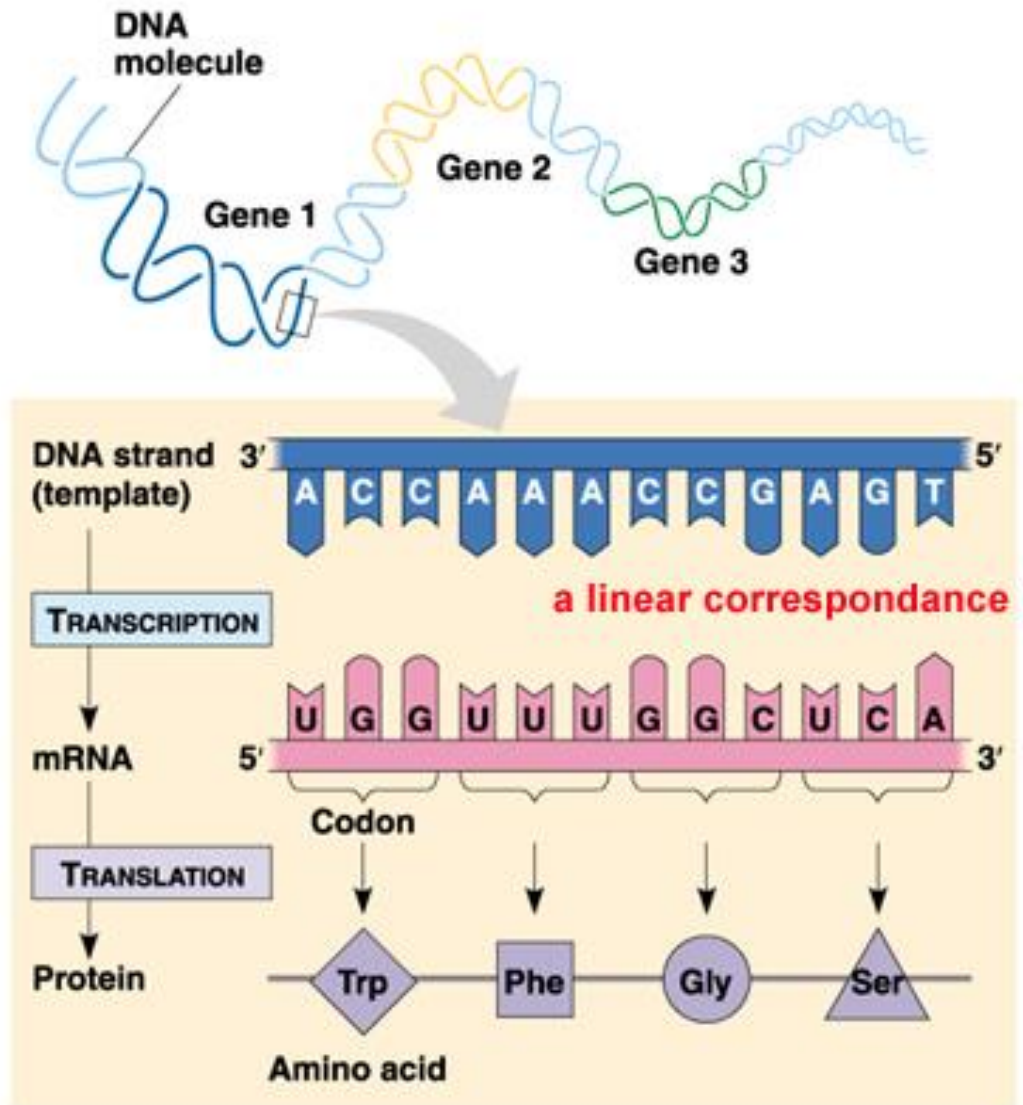
The polypeptide chain gets longer.

This continues until a termination (stop) codon is reached.

The polypeptide is then complete.



SUMMARY



MCQ

- (a) one gene responsible for the synthesis of one protein
- (b) Genetic code is universal
- (c)RNA has thiamine base
- (d) Transcription converts the mRNA base sequence to amino acids
- (e) Nucleus is the site of translation.

Thank You!