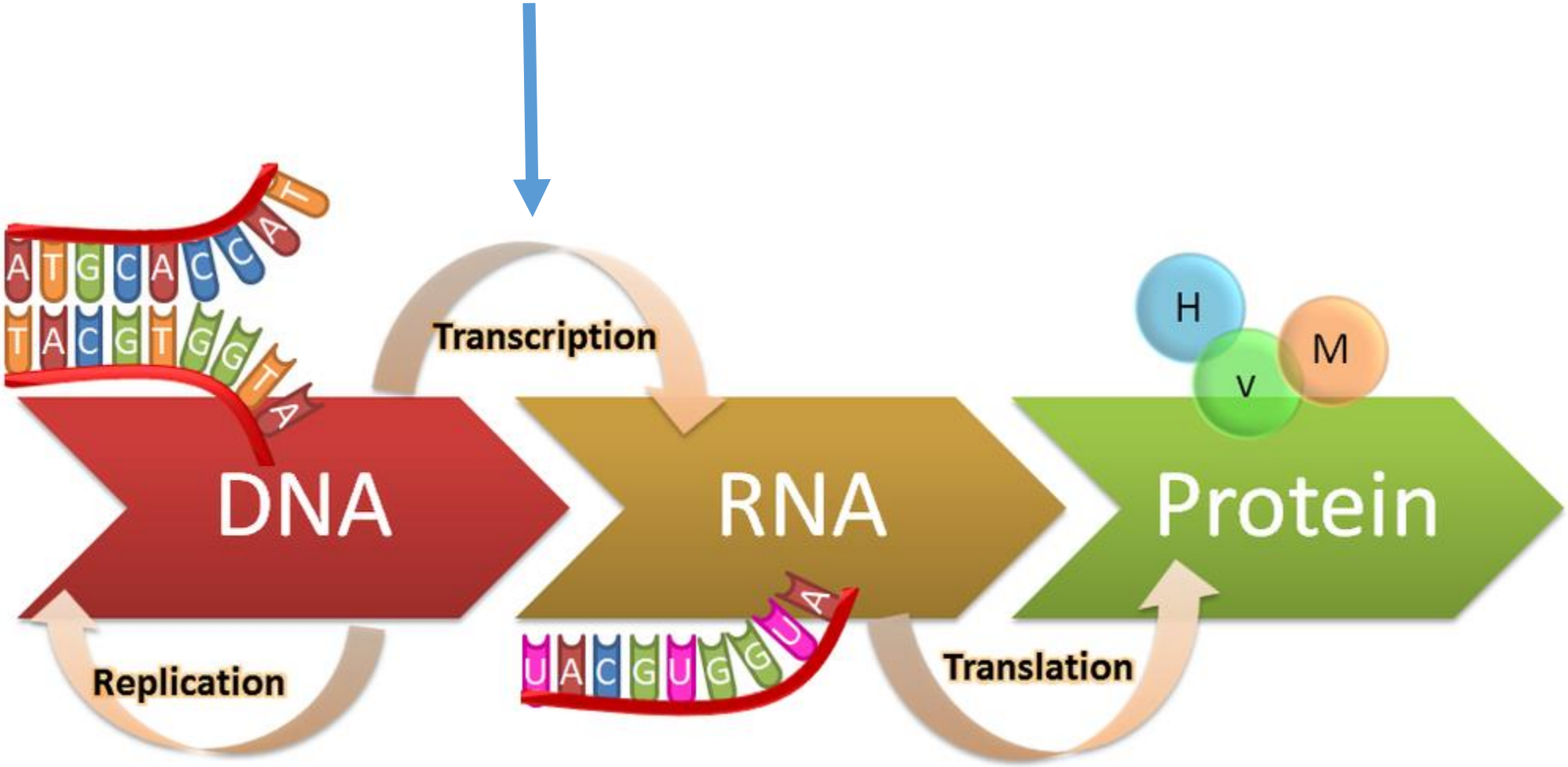
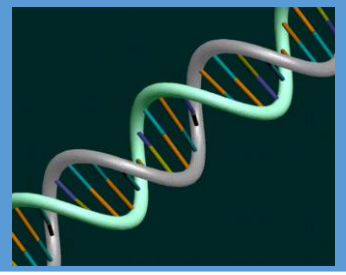
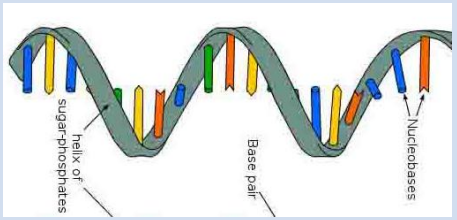
TRANSCRIPTION & TRANSLATION NOTES

TRANSCRIPTION



The “Central Dogma”

Protein Synthesis

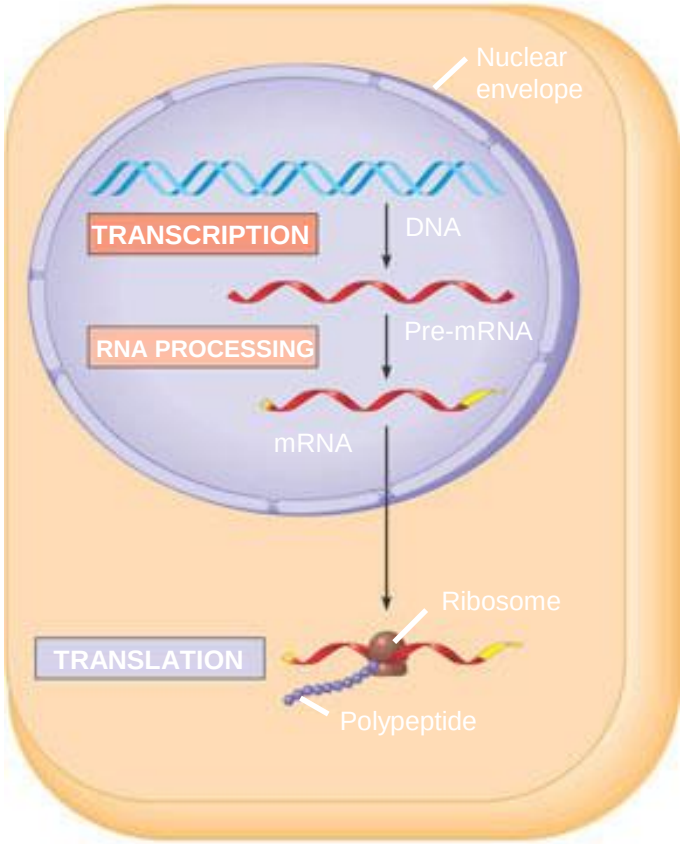
DNA ⇩	
RNA ⇩	
proteins ⇩	
you	

- The DNA inherited by an organism leads to specific traits by dictating the synthesis of proteins
- The process by which DNA directs protein synthesis, gene expression includes two stages, called transcription and translation

Transcription and Translation

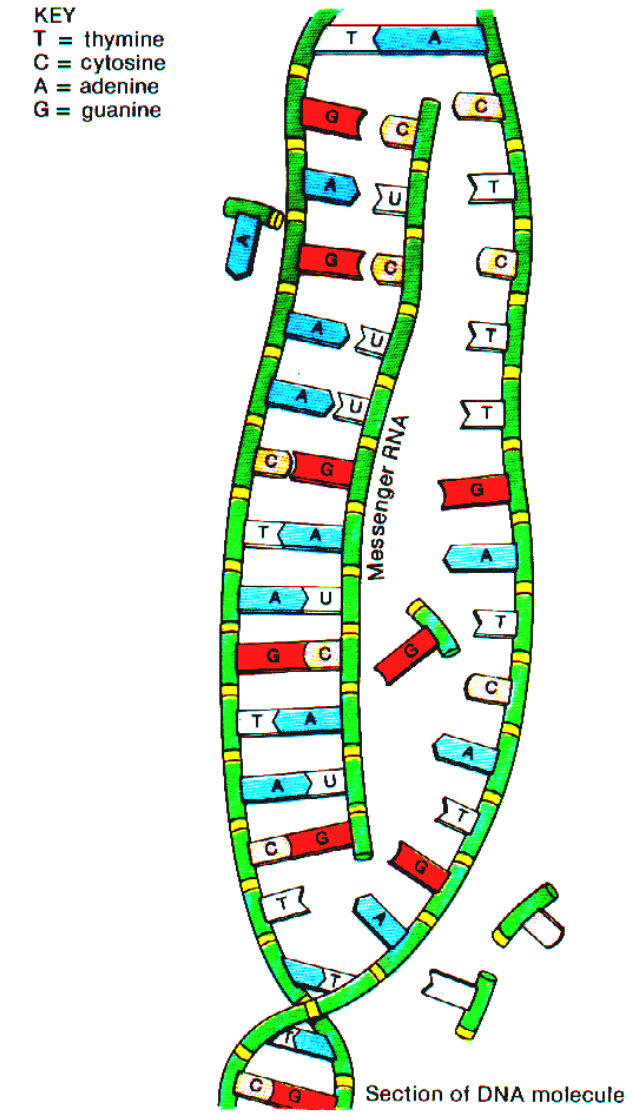
- Cells are governed by a cellular chain of command
  - DNA → RNA → protein
- Transcription
  - Is the synthesis of RNA under the direction of DNA
  - Produces messenger RNA (mRNA)
- Translation
  - Is the actual synthesis of a polypeptide, which occurs under the direction of mRNA
  - Occurs on ribosomes

- In a eukaryotic cell the nuclear envelope separates transcription from translation
- Extensive RNA processing occurs in the nucleus



Transcription

- Transcription is the DNA-directed synthesis of RNA
- RNA synthesis
  - Is catalyzed by RNA polymerase, which pries the DNA strands apart and hooks together the RNA nucleotides
  - Follows the same base-pairing rules as DNA, except that in RNA, uracil substitutes for thymine



Five differences between RNA and DNA

1. Sugar in RNA is ribose instead of deoxyribose
2. RNA is single stranded and short
3. RNA contains Uracil instead of Thymine
4. RNA is disposable
5. RNA can be outside the nucleus, DNA can't

If you are going from DNA to RNA – what nitrogenous base would pair with Adenine?

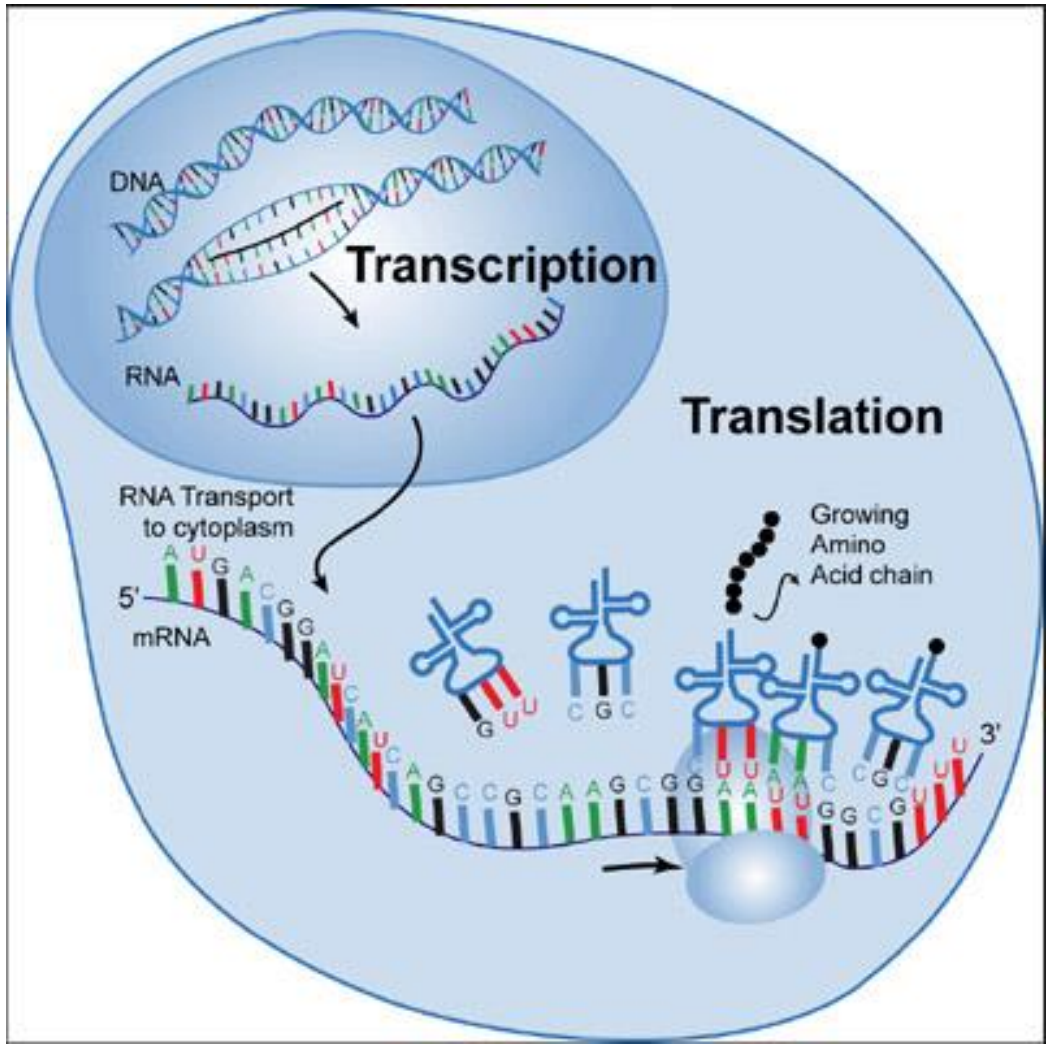
DNA: C A G T T A

RNA: _ _ _ _ _ _

Types of RNA

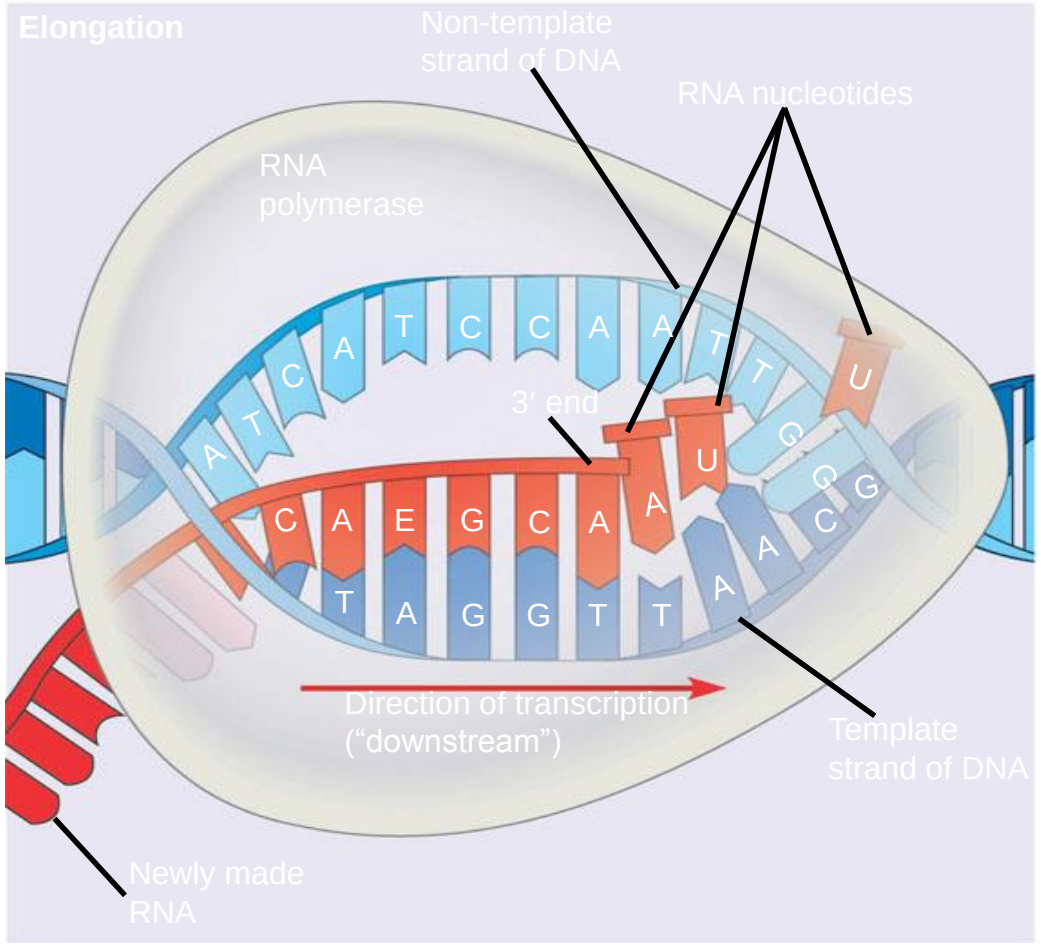
- Key players in Protein Synthesis -
  - Messenger RNA (mRNA): carry instruction copies
  - Ribosomal RNA (rRNA): makes up ribosome along with proteins
  - Transfer RNA (tRNA): brings amino acids to the ribosome

Big picture of protein synthesis

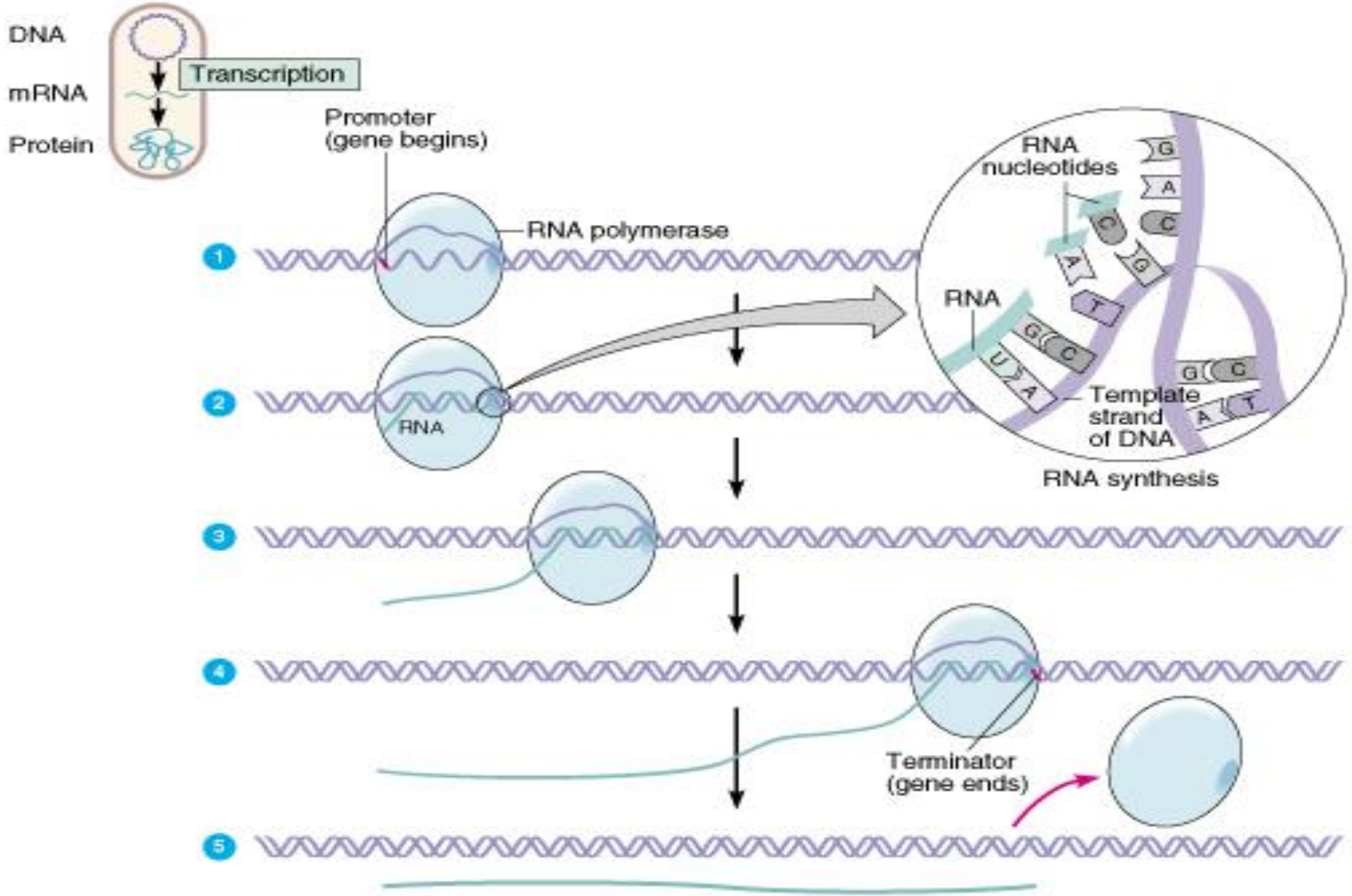


Synthesis of an RNA Transcript

- RNA polymerase synthesizes a single strand of RNA against the DNA template strand, adding nucleotides to the 3’ end of the RNA chain
- As RNA polymerase moves along the DNA it continues to untwist the double helix, exposing about 10 to 20 DNA bases at a time for pairing with RNA nucleotides
- Specific sequences in the DNA signal termination of transcription
- When one of these is encountered by the polymerase, the RNA transcript is released from the DNA and the double helix can zip up again.

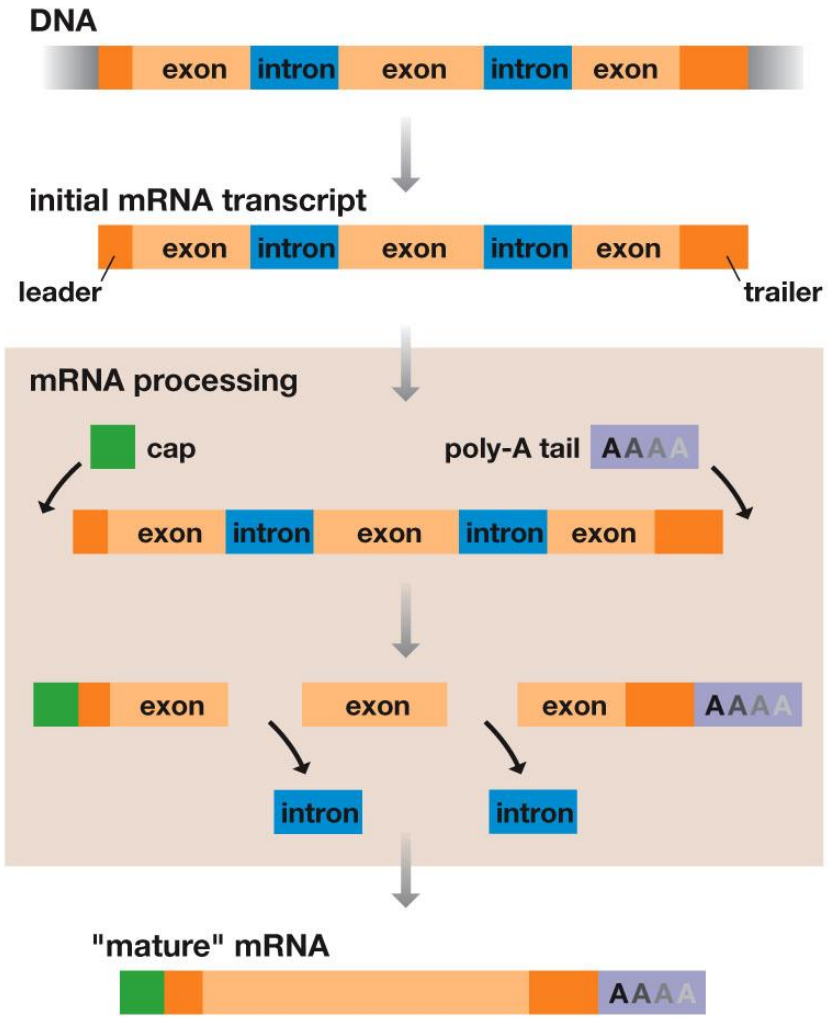


Transcription Overview

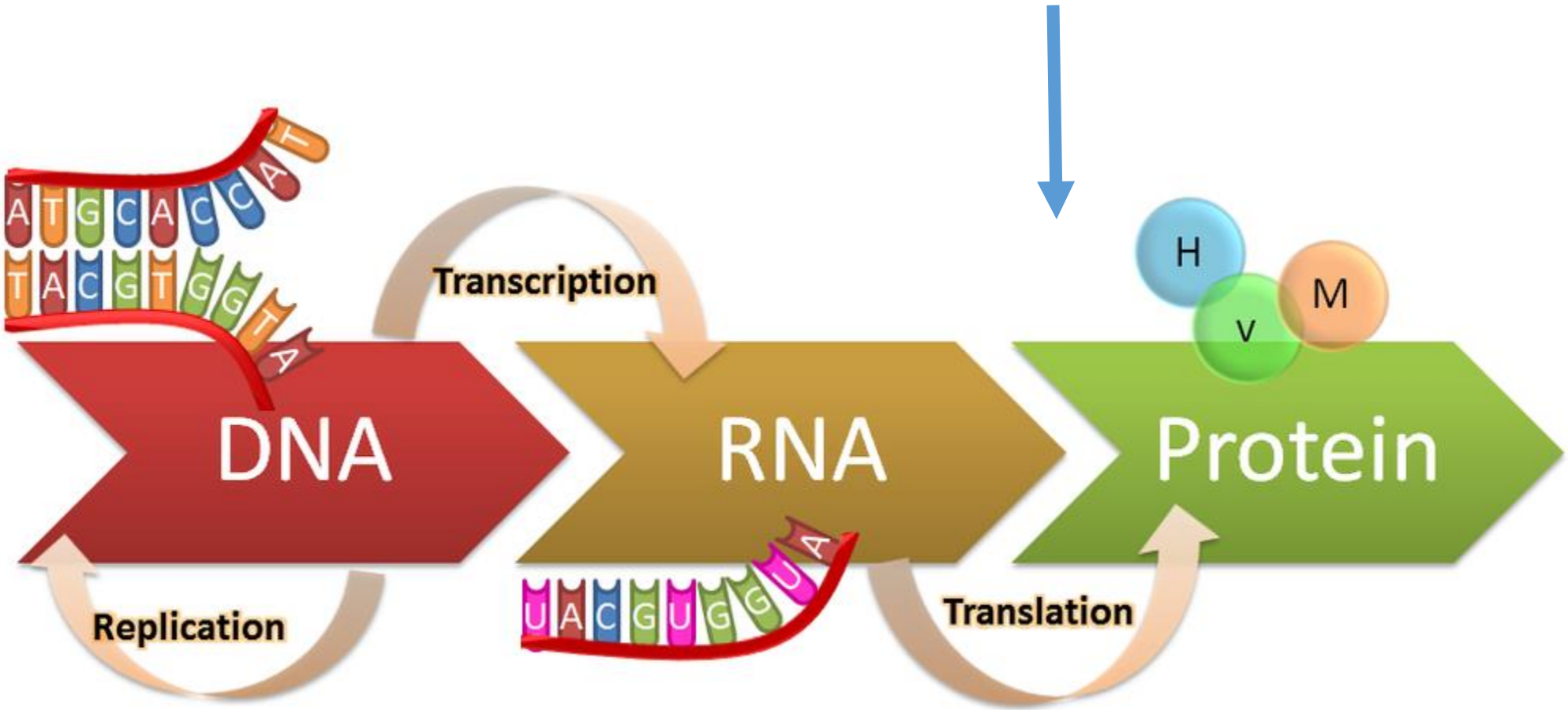


Post RNA Processing

- Most eukaryotic mRNAs aren't ready to be translated into protein directly after being transcribed from DNA. mRNA requires processing. Transcription of RNA processing occur in the nucleus. After this, the messenger RNA moves to the cytoplasm for translation.
- The cell adds a protective cap to one end. These both function to protect the RNA from enzymes that would degrade
- Most of the genome consists of non-coding regions called **introns**
  - Non-coding regions may have specific chromosomal functions or have regulatory purposes
  - Introns also allow for alternative RNA splicing
- Thus, an RNA copy of a gene is converted into messenger RNA by doing 2 things:
  - Add protective bases to the ends
  - Cut out the introns
- The original transcript from the DNA is called pre-mRNA.
- It contains transcripts of both introns and exons.
- The introns are removed by a process called splicing to produce messenger RNA (mRNA)

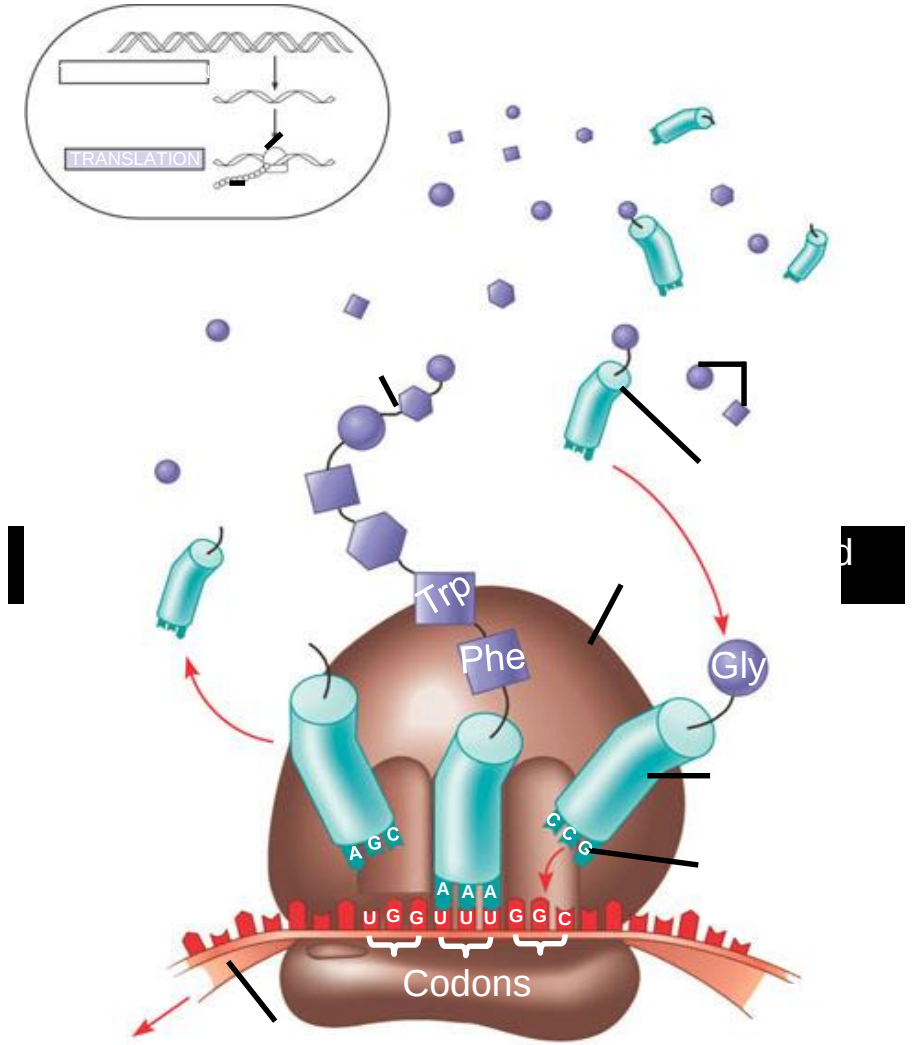


TRANSLATION



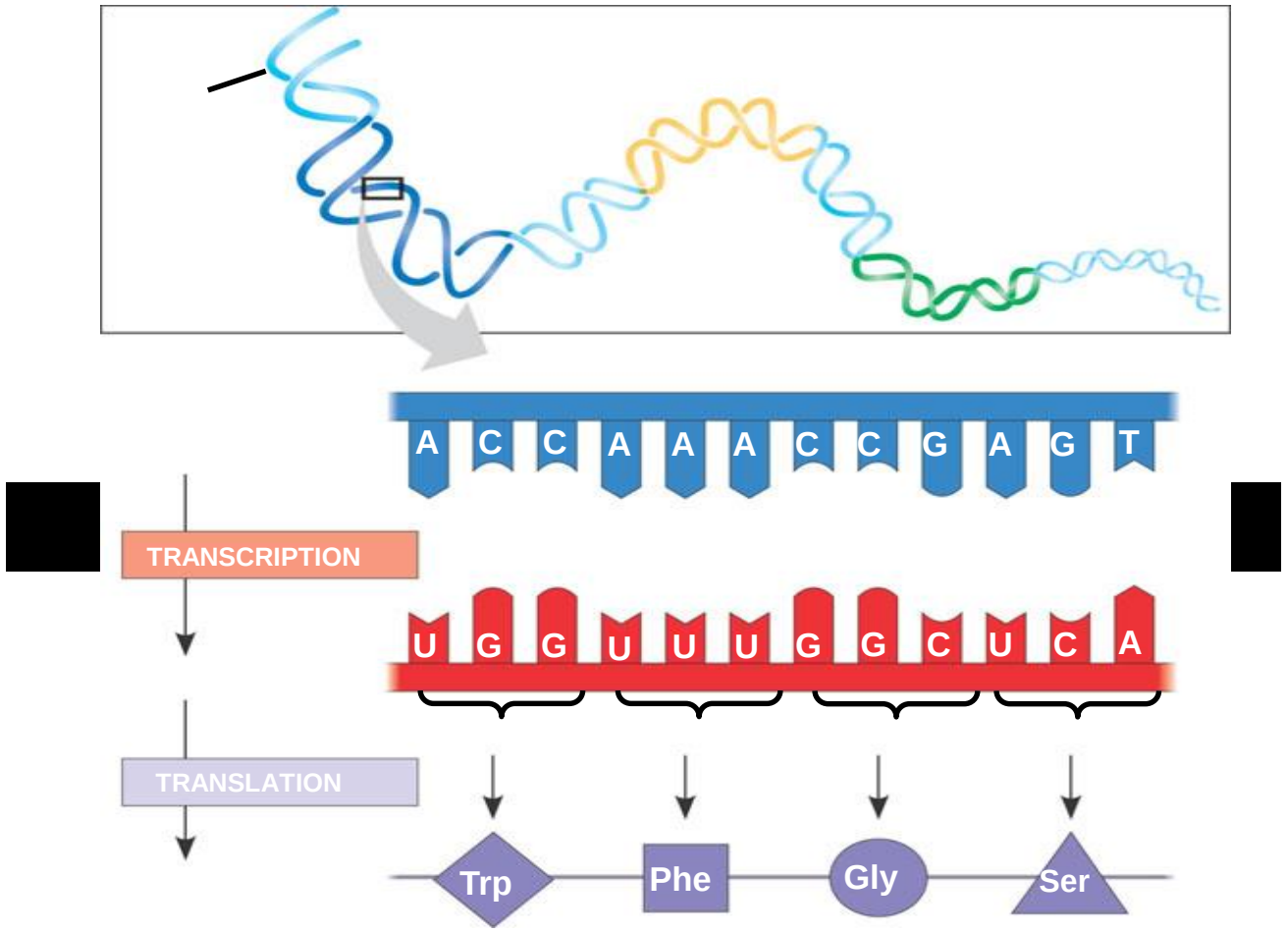
Translation

- Translation is the RNA-directed synthesis of a polypeptide
- Translation involves
  - mRNA
  - Ribosomes - Ribosomal RNA
  - tRNA
  - Genetic coding - codons



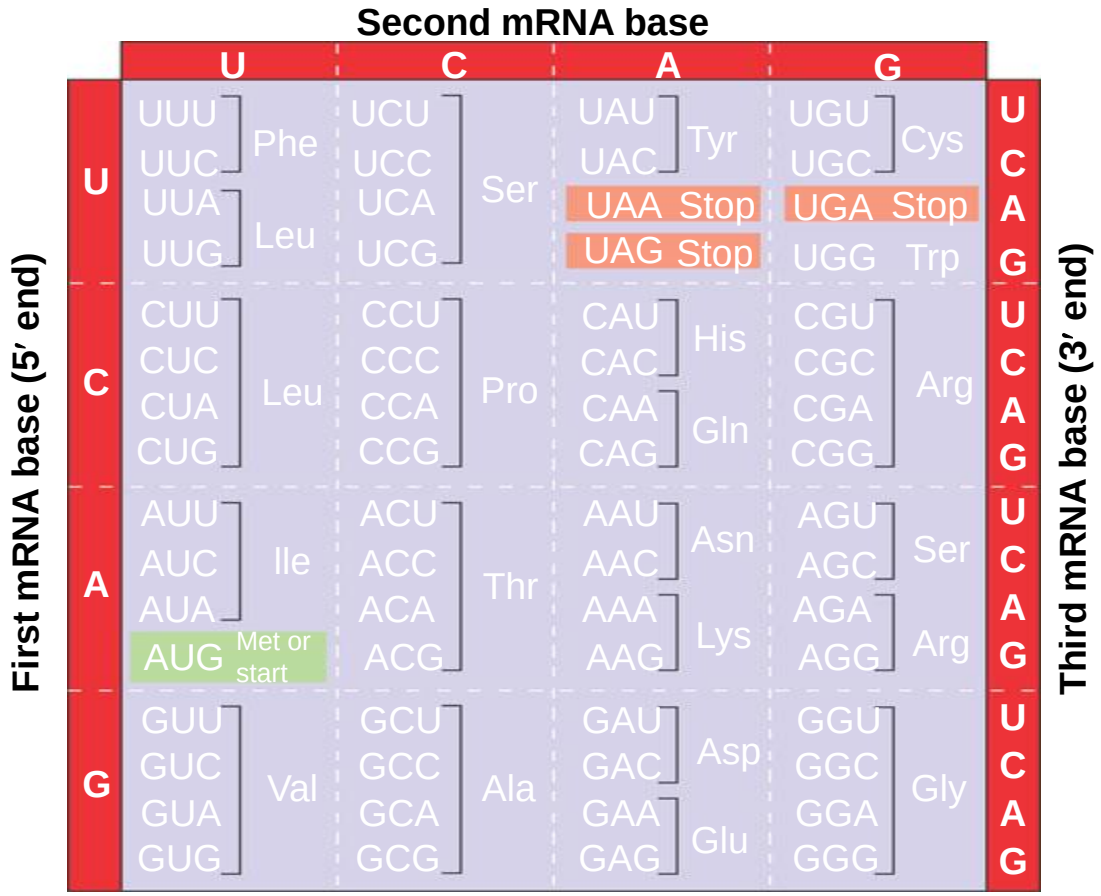
The Genetic Code

- Genetic information is encoded as a sequence of non-overlapping base triplets, or codons



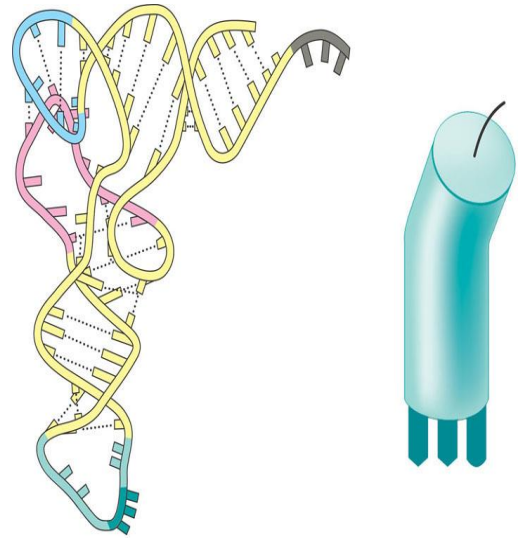
The Genetic Code

- Codons: 3 base code for the production of a specific amino acid, sequence of three of the four different nucleotides
- Since there are 4 bases and 3 positions in each codon, 64 possible codons, but only 20 amino acids, therefore most have more than 1 codon
- 3 of the 64 codons are used as STOP signals; they are found at the end of every gene and mark the end of the protein
- One codon is used as a START signal: it is at the start of every protein



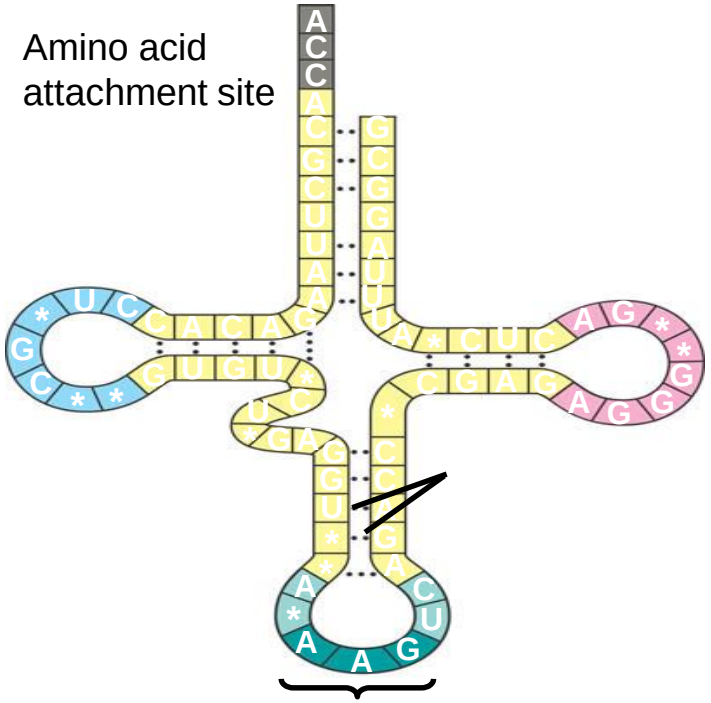
A codon in messenger RNA is either translated into an amino acid or serves as a translational start/stop signal

Transfer RNA



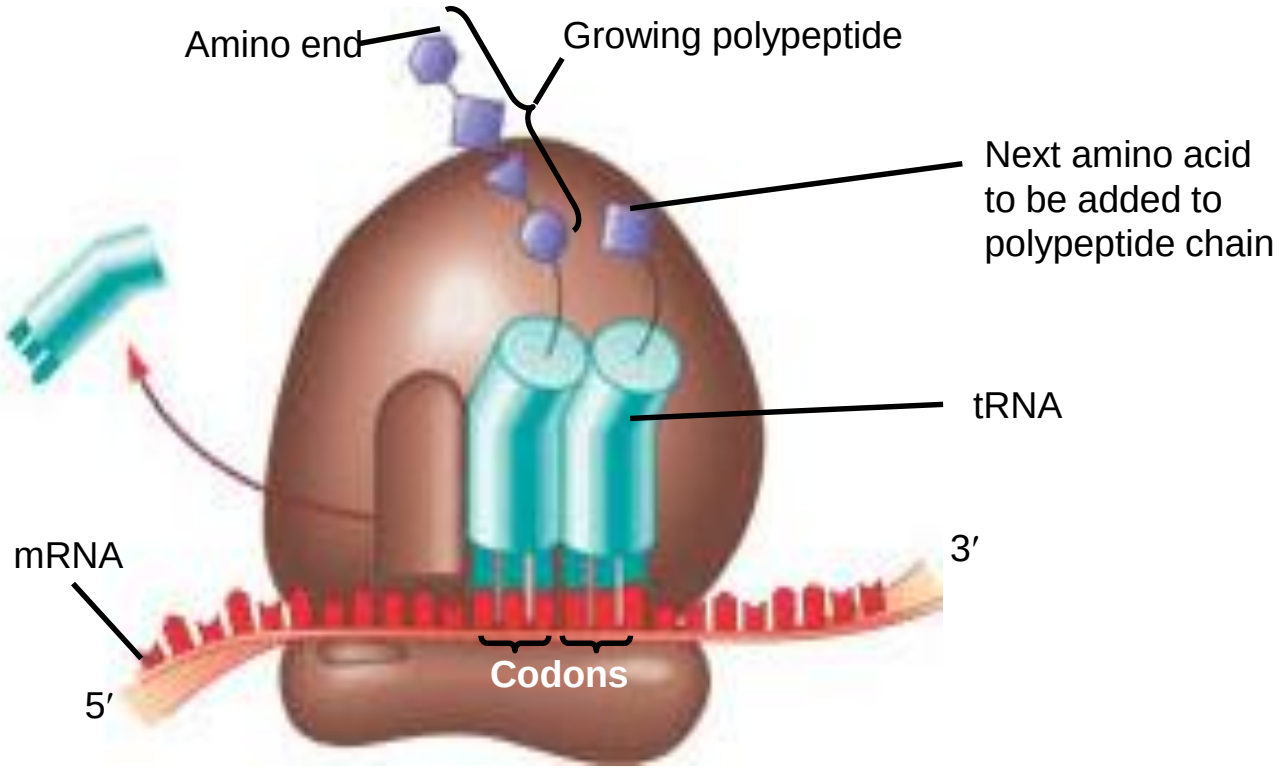
- Consists of a single RNA strand that is only about 80 nucleotides long
- Each carries a specific amino acid on one end and has an anticodon on the other end
- A special group of enzymes pairs up the proper tRNA molecules with their corresponding amino acids.
- tRNA brings the amino acids to the ribosomes,

The “anticodon” is the 3 RNA bases that matches the 3 bases of the codon on the mRNA molecule



Two-dimensional structure. The four base-paired regions and three loops are characteristic of all tRNAs, as is the base sequence of the amino acid attachment site at the 3′ end. The anticodon triplet is unique to each tRNA type. (The asterisks mark bases that have been chemically modified, a characteristic of tRNA.)

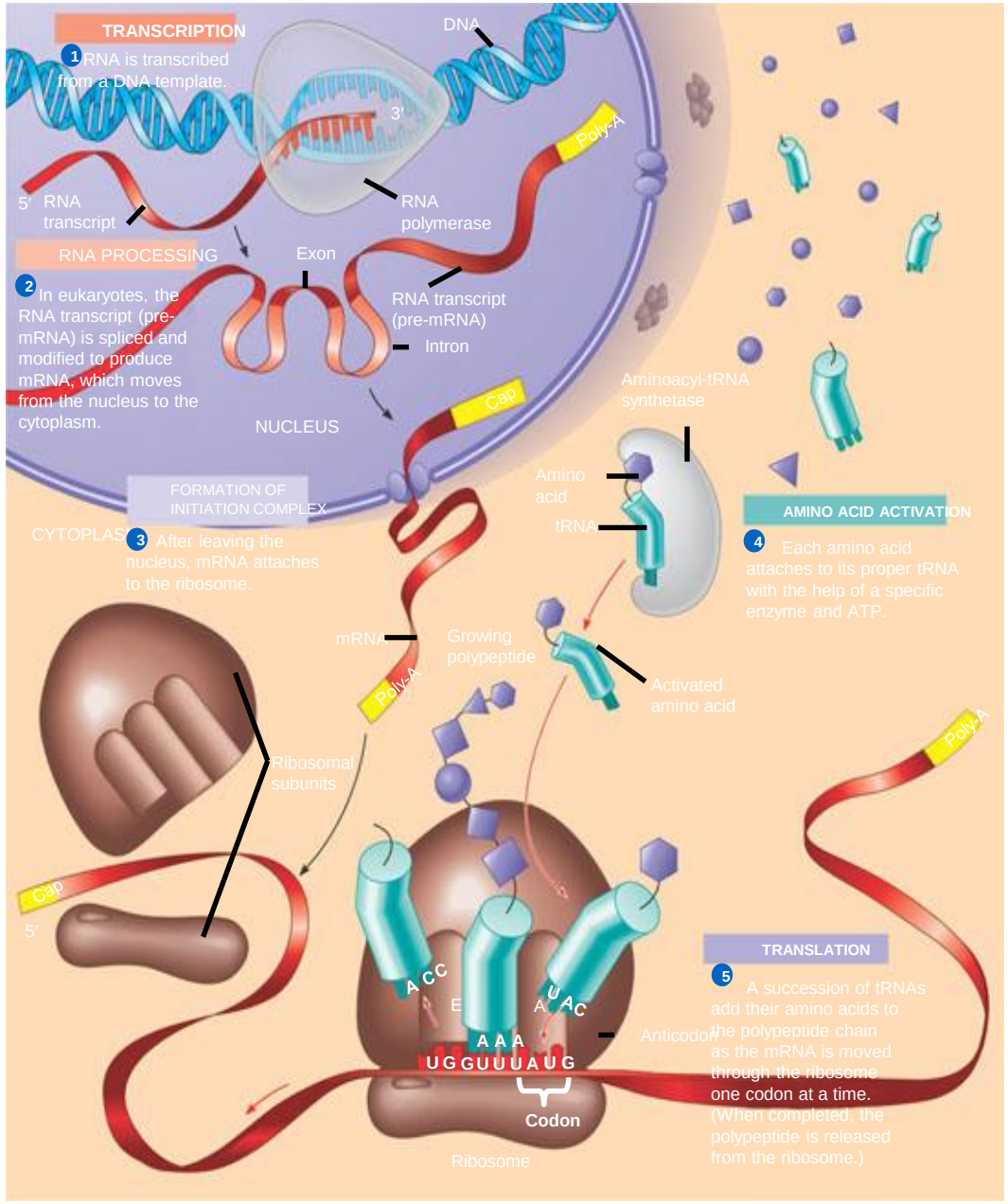
Building a Polypeptide

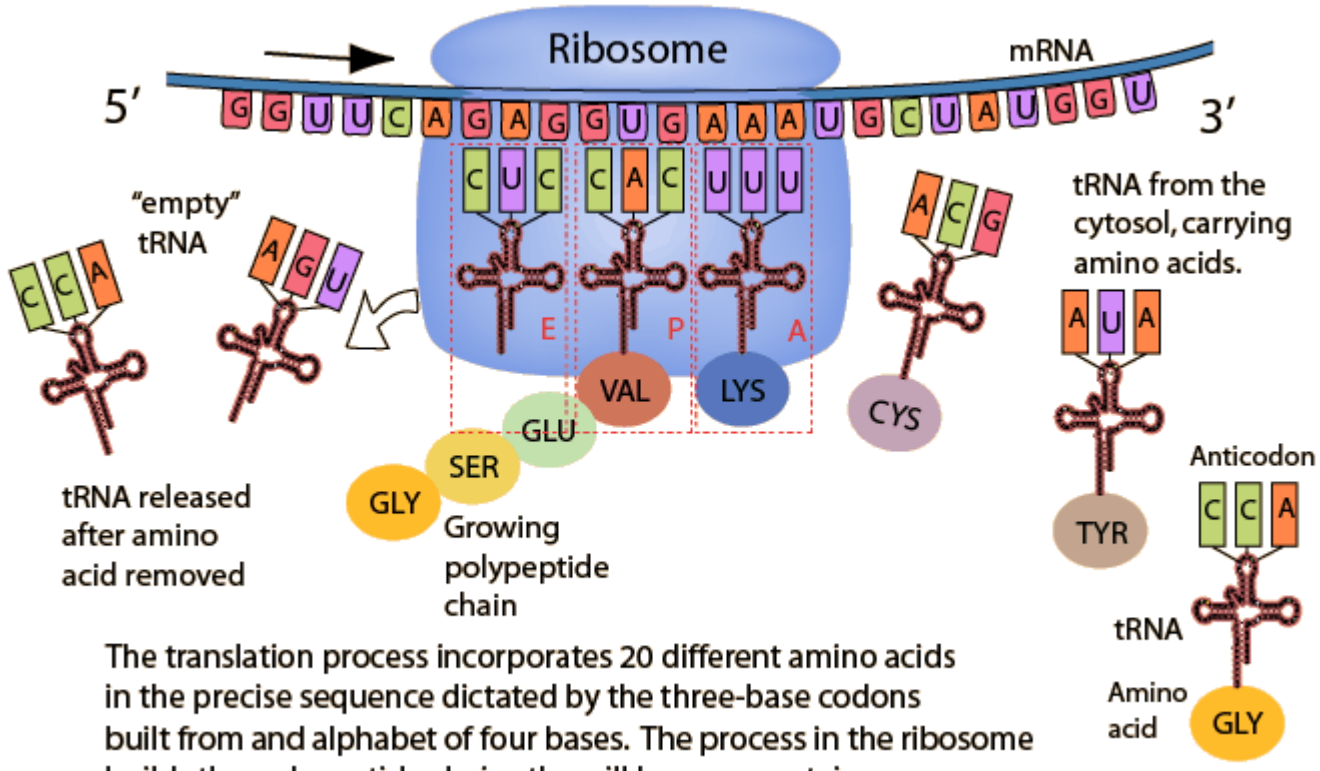


Schematic model with mRNA and tRNA. A tRNA fits into a binding site when its anticodon base-pairs with an mRNA codon. The P site holds the tRNA attached to the growing polypeptide. The A site holds the tRNA carrying the next amino acid to be added to the polypeptide chain. Discharged tRNA leaves via the E site.

- The AUG start codon is recognized by methionyl-tRNA or Met
- Once the start codon has been identified, the ribosome incorporates amino acids into a polypeptide chain
- RNA is decoded by tRNA (transfer RNA) molecules, which each transport specific amino acids to the growing chain
- Translation ends when a stop codon (UAA, UAG, UGA) is reached

A summary of transcription and translation in a eukaryotic cell

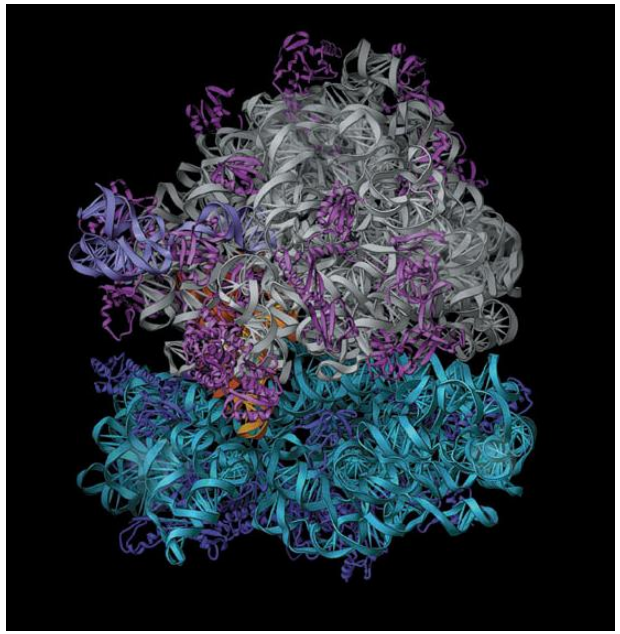




The translation process incorporates 20 different amino acids in the precise sequence dictated by the three-base codons built from and alphabet of four bases. The process in the ribosome builds the polypeptide chains tha will become proteins.

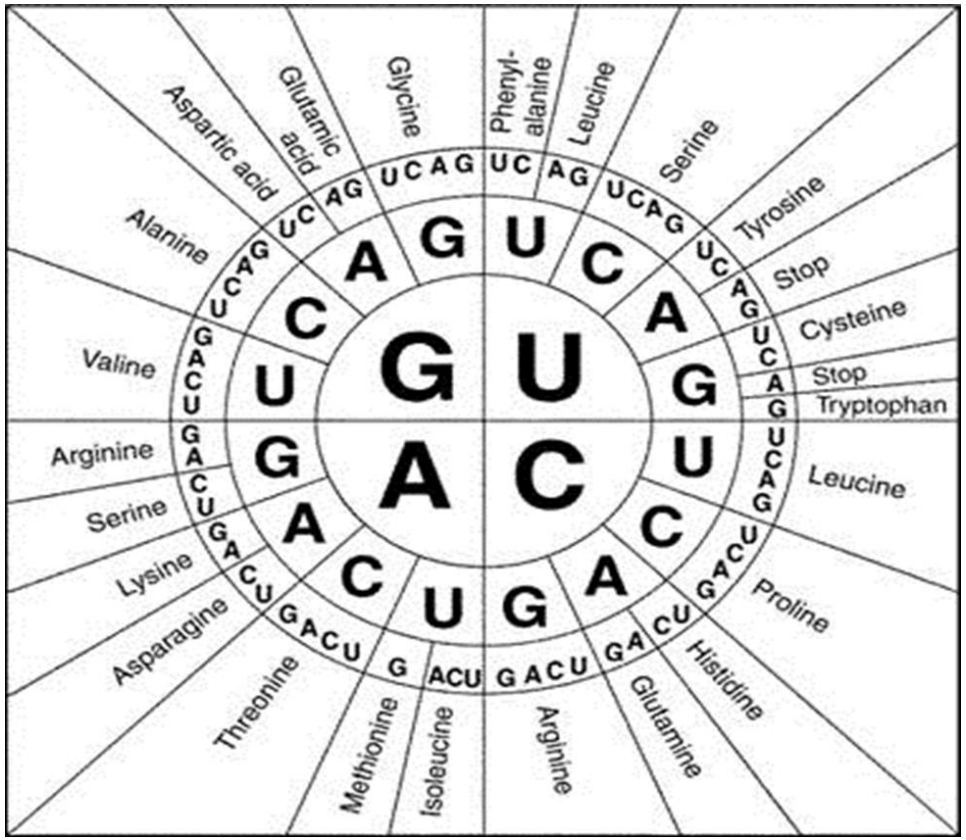
Post-translation

- The new polypeptide is now floating loose in the cytoplasm if translated by a free ribosome.
- It might also be inserted into a membrane, if translated by a ribosome bound to the endoplasmic reticulum.
- Polypeptides fold spontaneously into their active configuration, and they spontaneously join with other polypeptides to form the final proteins.
- Sometimes other molecules are also attached to the polypeptides: sugars, lipids, phosphates, etc. All of these have special purposes for protein function.



Just Like Construction…

- DNA is the master plan
- mRNA is the everyday blueprint
- rRNA is the builder
- tRNA is the gopher
- Amino Acids are the wood
- Proteins are the building



1. What amino acids would be coded by the following DNA sequence?

CGGACCGCTATC