Transcription and Translation

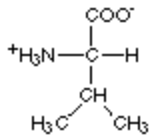
Chapter 14

p. 263-273

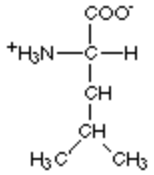
Protein Structure

- Made up of amino acids
- Polypeptide- string of amino acids
- 20 amino acids are arranged in different orders to make a variety of proteins
- Assembled on a ribosome

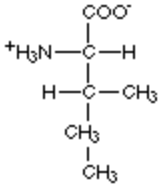
Amino acids with hydrophobic side groups



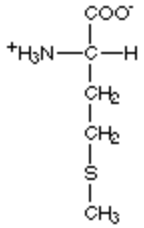
Valine
(val)



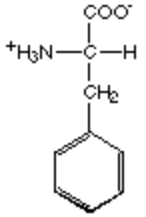
Leucine
(leu)



Isoleucine
(ile)

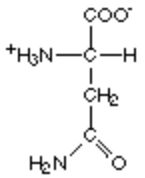


Methionine
(met)

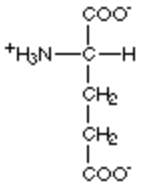


Phenylalanine
(phe)

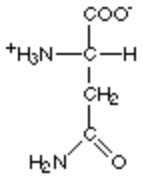
Amino acids with hydrophilic side groups



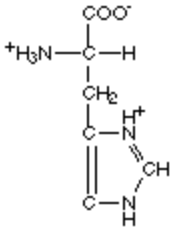
Asparagine
(asn)



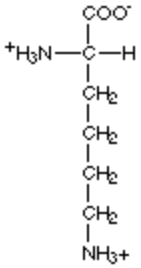
Glutamic acid
(glu)



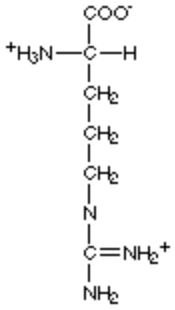
Glutamine
(gln)



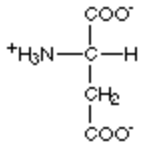
Histidine
(his)



Lysine
(lys)

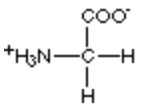


Arginine
(arg)

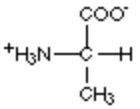


Aspartic acid
(asp)

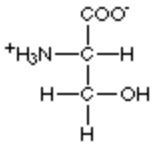
Amino acids that are inbetween



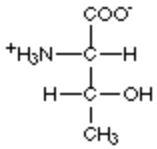
Glycine
(gly)



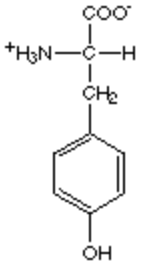
Alanine
(ala)



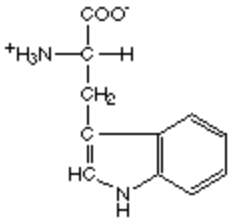
Serine
(ser)



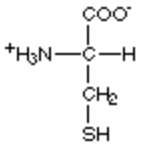
Threonine
(thr)



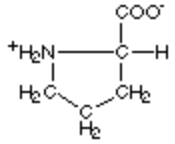
Tyrosine
(tyr)



Tryptophan
(trp)



Cysteine
(cys)

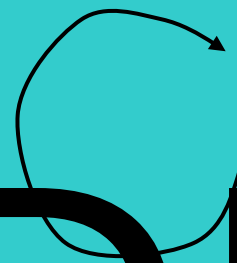


Proline
(pro)

Questions to be answered today

- How do we get from the bases found in DNA to amino acids?
- How do we get from a bunch of amino acids to proteins?

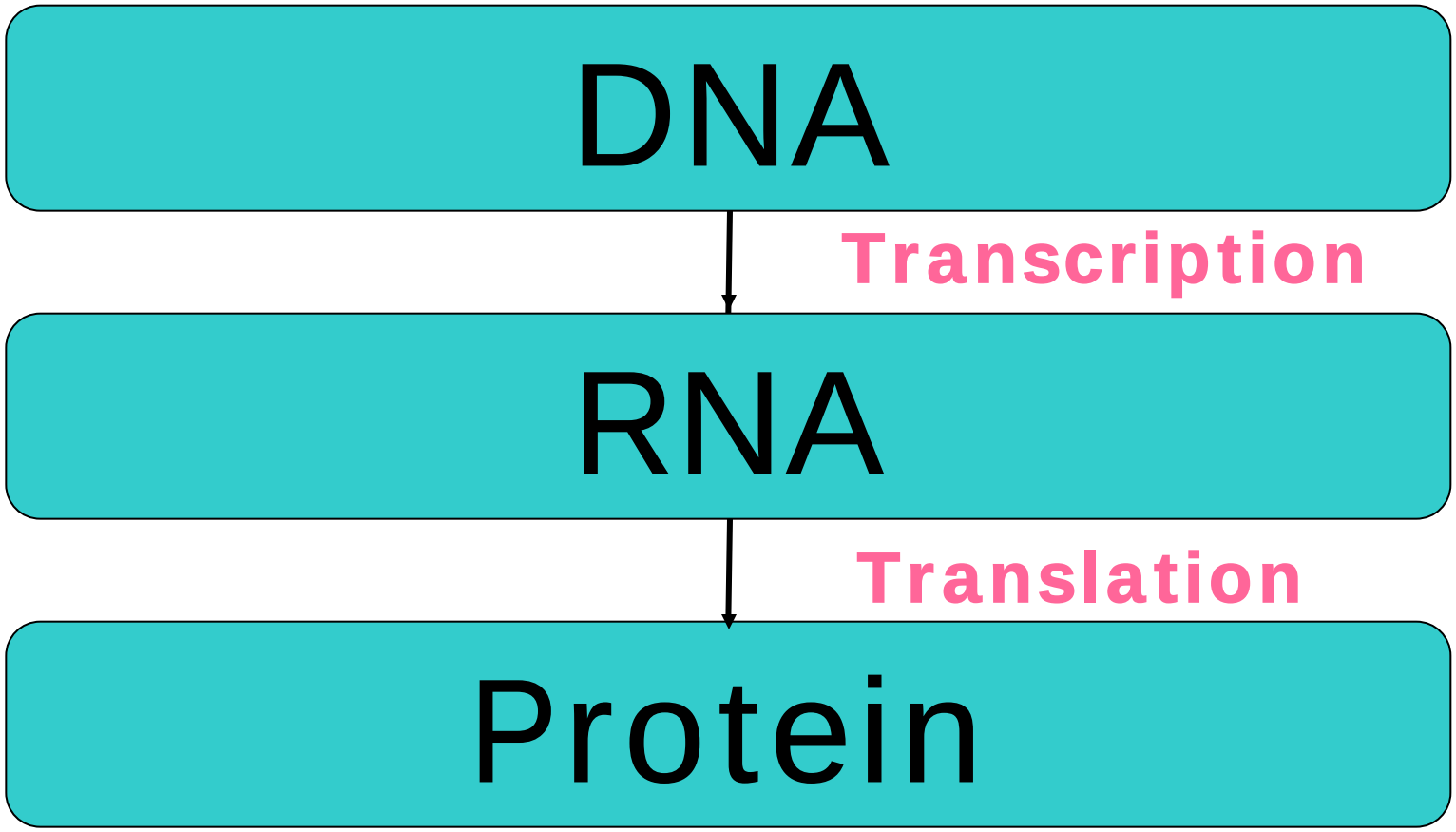
Replication



DNA

- DNA double helix unwinds
- DNA now single-stranded
- New DNA strand forms using complementary base pairing (A-T, C-G)
- Used to prepare DNA for cell division
- Whole genome copied/replicated

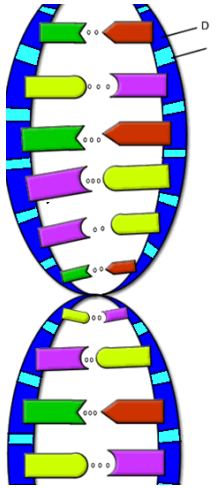
Transcription and Translation: An Overview (aka the Central Dogma)



RNA vs. DNA

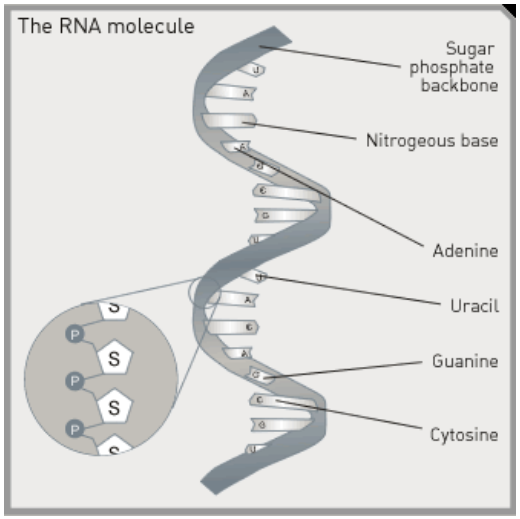
DNA

- Double stranded
- Deoxyribose sugar
- Bases: C,G A,T



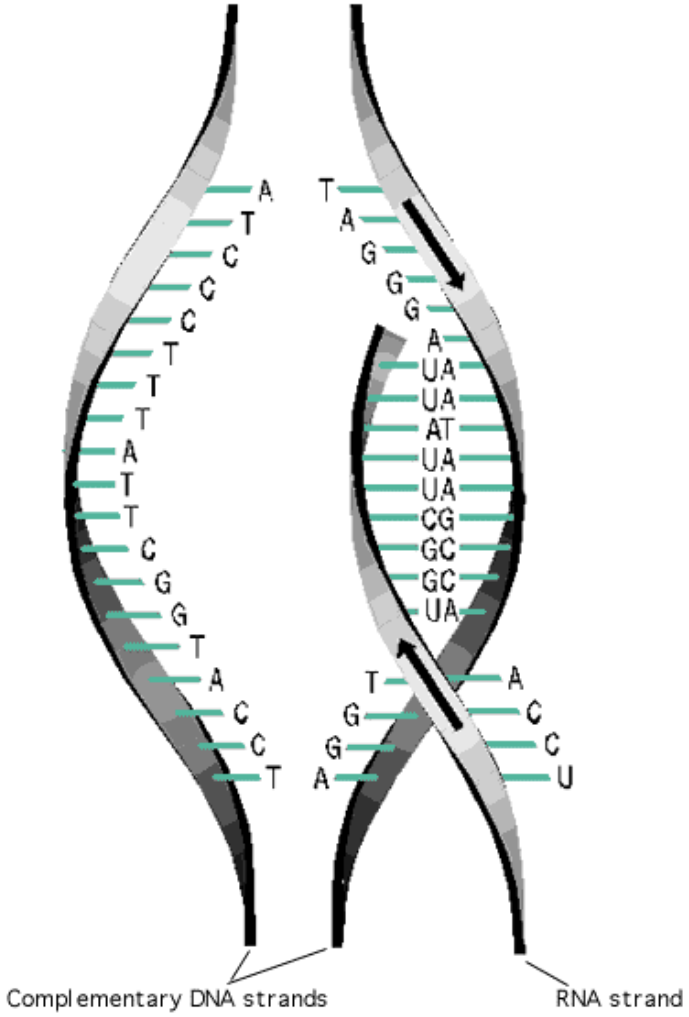
RNA

- Single stranded
- Ribose sugar
- Bases: C,G,A,U



Both contain a sugar, phosphate, and base.

Transcription



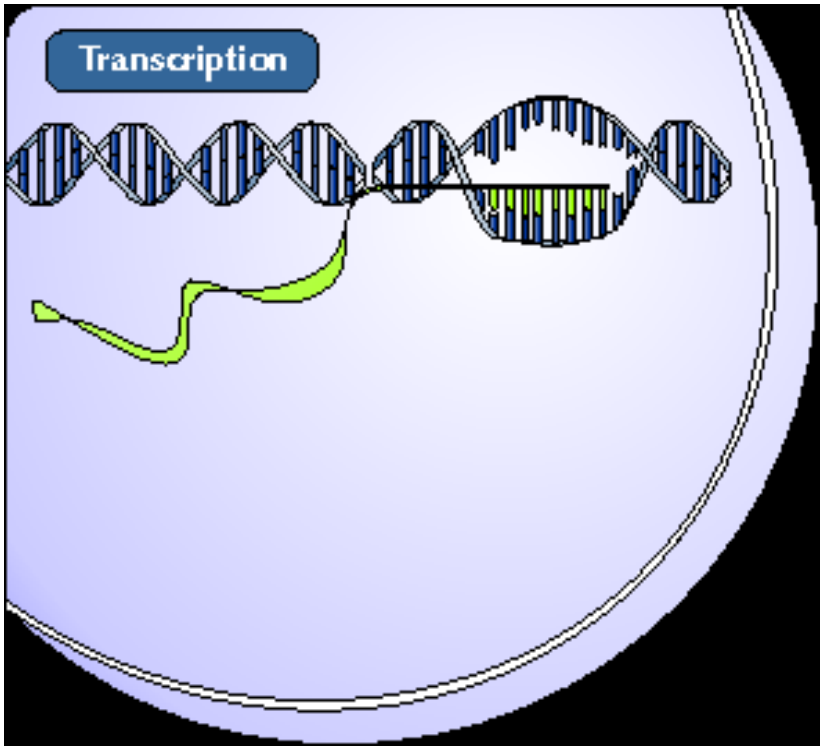
- RNA forms base pairs with DNA
  - C-G
  - A-U
- Primary transcript- length of RNA that results from the process of transcription

TRANSCRIPTION

ACGATACCCTGACGAGCGTTAGCTATCG

UGCUAUGGGACU

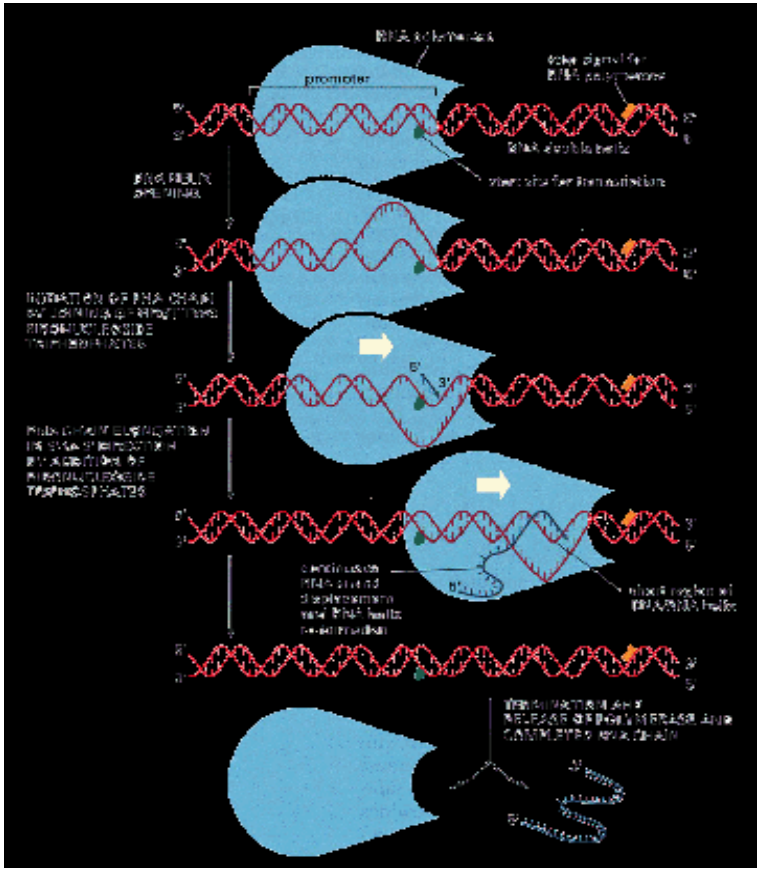
Major players in transcription



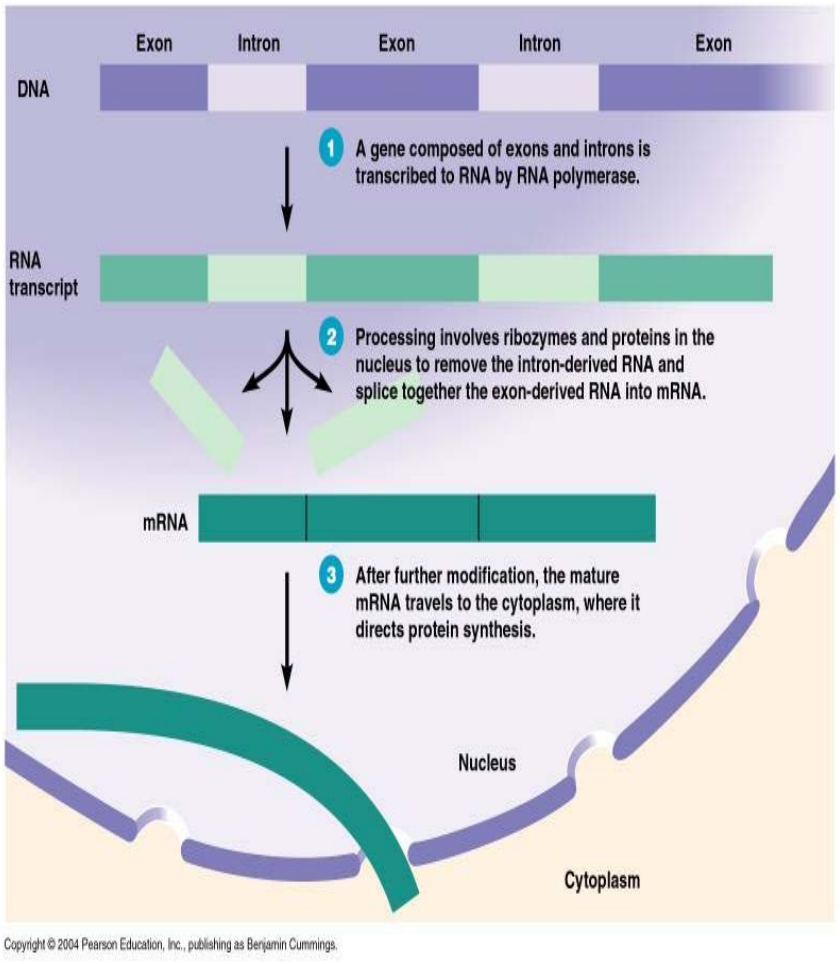
- mRNA- type of RNA that encodes information for the synthesis of proteins and carries it to a ribosome from the nucleus

Major players in transcription

- RNA polymerase- complex of enzymes with 2 functions:
  - Unwind DNA sequence
  - Produce primary transcript by stringing together the chain of RNA nucleotides



mRNA Processing



- Primary transcript is not mature mRNA
- DNA sequence has coding regions (exons) and non-coding regions (introns)
- Introns must be removed before primary transcript is mRNA and can leave nucleus

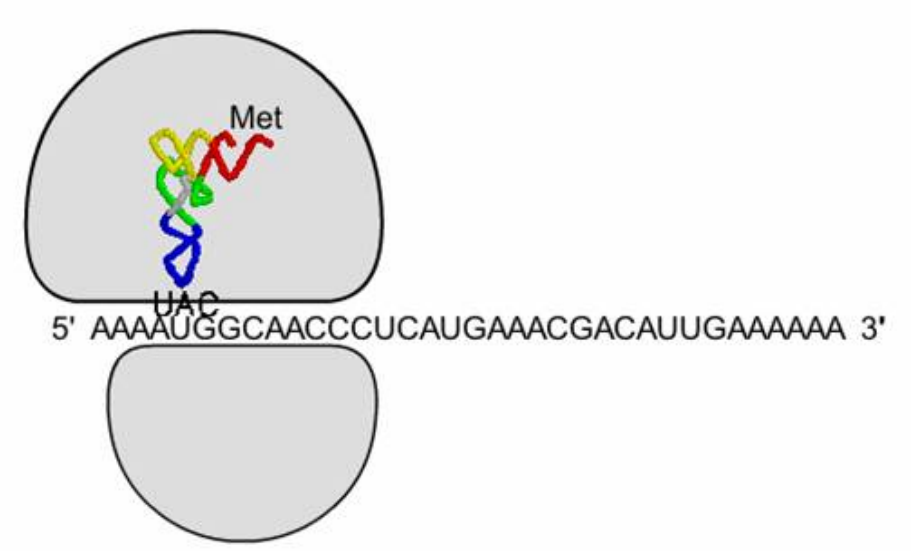
Transcription is done…what now?

Now we have mature mRNA transcribed from the cell's DNA. It is leaving the nucleus through a nuclear pore. Once in the cytoplasm, it finds a ribosome so that translation can begin.

We know how mRNA is made, but how do we "read" the code?

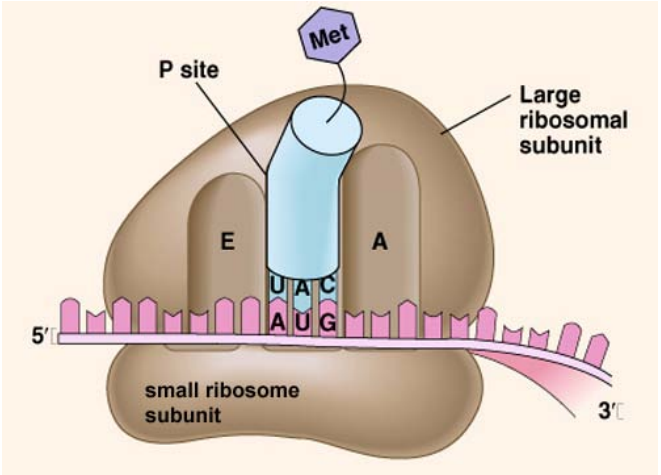
Translation

- Second stage of protein production
- mRNA is on a ribosome



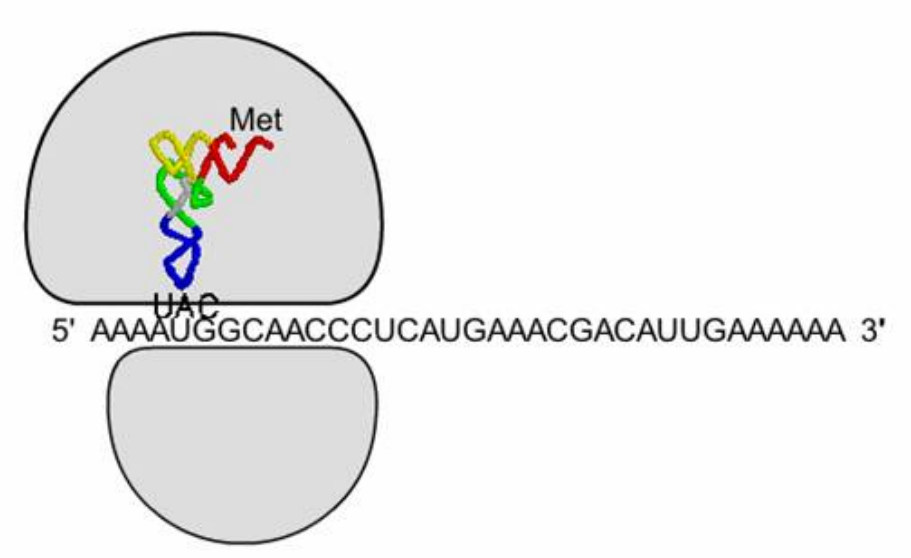
Ribosomes

- 2 subunits, separate in cytoplasm until they join to begin translation
  - Large
  - Small
- Contain 3 binding sites
  - E
  - P
  - A

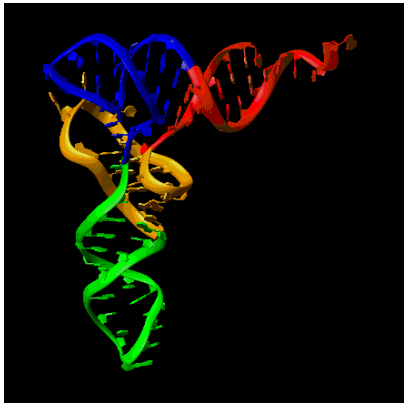


Translation

- Second stage of protein production
- mRNA is on a ribosome
- tRNA brings amino acids to the ribosome



tRNA



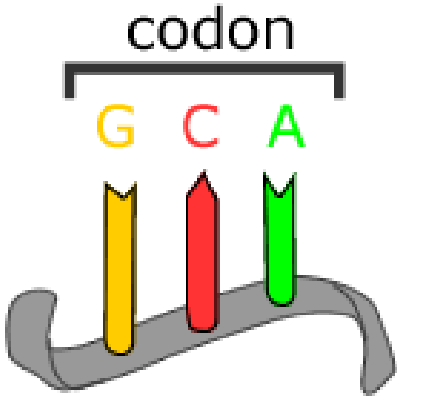
- Transfer RNA
- Bound to one amino acid on one end
- Anticodon on the other end complements mRNA codon

tRNA Function

- Amino acids must be in the correct order for the protein to function correctly
- tRNA lines up amino acids using mRNA code

Reading the DNA code

- Every 3 DNA bases pairs with 3 mRNA bases
- Every group of 3 mRNA bases encodes a single amino acid
- Codon- coding triplet of mRNA bases

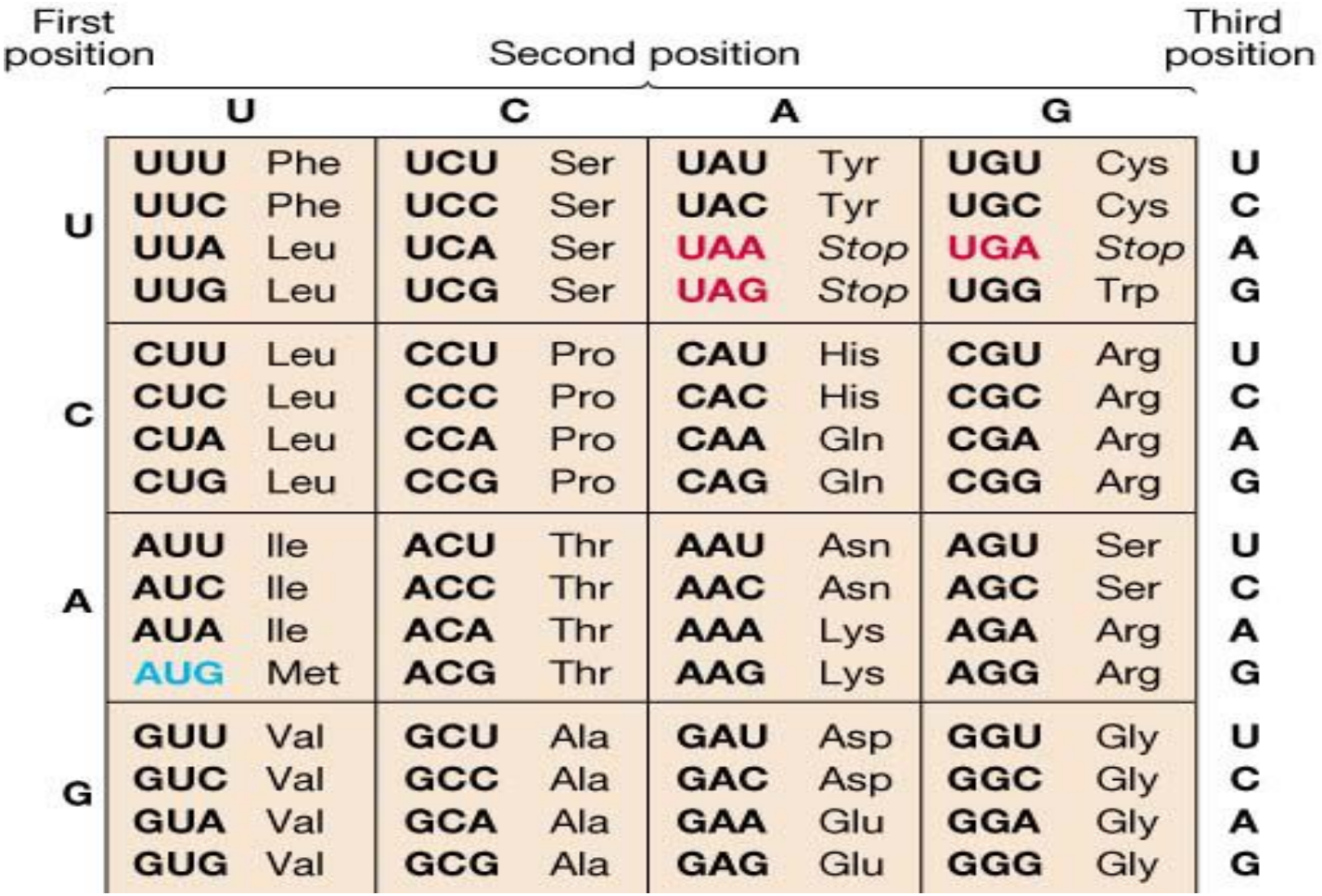


1 codon = 1 amino acid

How many bases code for each amino acid?

- 1 base = 1 amino acid
  - 4^1 =
- 2 bases = 1 amino acid
  - 4^2 =
- 3 bases = 1 amino acid
  - 4^3 =

The Genetic Code



First position	Second position: U		Second position: C		Second position: A		Second position: G		Third position
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U
	UUC	Phe	UCC	Ser	UAC	Tyr	UGC	Cys	C
	UUA	Leu	UCA	Ser	UAA	*Stop*	UGA	*Stop*	A
	UUG	Leu	UCG	Ser	UAG	*Stop*	UGG	Trp	G
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U
	CUC	Leu	CCC	Pro	CAC	His	CGC	Arg	C
	CUA	Leu	CCA	Pro	CAA	Gln	CGA	Arg	A
	CUG	Leu	CCG	Pro	CAG	Gln	CGG	Arg	G
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U
	AUC	Ile	ACC	Thr	AAC	Asn	AGC	Ser	C
	AUA	Ile	ACA	Thr	AAA	Lys	AGA	Arg	A
	AUG	Met	ACG	Thr	AAG	Lys	AGG	Arg	G
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U
	GUC	Val	GCC	Ala	GAC	Asp	GGC	Gly	C
	GUA	Val	GCA	Ala	GAA	Glu	GGA	Gly	A
	GUG	Val	GCG	Ala	GAG	Glu	GGG	Gly	G

ACGATACCCTGACGAGCGTTAGCTATCG
UGCUAUGGGACUG

First position	Second position U		Second position C		Second position A		Second position G		Third position
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U
	UUC	Phe	UCC	Ser	UAC	Tyr	UGC	Cys	C
	UUA	Leu	UCA	Ser	UAA	*Stop*	UGA	*Stop*	A
	UUG	Leu	UCG	Ser	UAG	*Stop*	UGG	Trp	G
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U
	CUC	Leu	CCC	Pro	CAC	His	CGC	Arg	C
	CUA	Leu	CCA	Pro	CAA	Gln	CGA	Arg	A
	CUG	Leu	CCG	Pro	CAG	Gln	CGG	Arg	G
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U
	AUC	Ile	ACC	Thr	AAC	Asn	AGC	Ser	C
	AUA	Ile	ACA	Thr	AAA	Lys	AGA	Arg	A
	AUG	Met	ACG	Thr	AAG	Lys	AGG	Arg	G
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U
	GUC	Val	GCC	Ala	GAC	Asp	GGC	Gly	C
	GUA	Val	GCA	Ala	GAA	Glu	GGA	Gly	A
	GUG	Val	GCG	Ala	GAG	Glu	GGG	Gly	G

Which codons code for which amino acids?

- Genetic code- inventory of linkages between nucleotide triplets and the amino acids they code for
- A gene is a segment of RNA that brings about transcription of a segment of RNA

Transcription vs. Translation Review

Transcription

- Process by which genetic information encoded in DNA is copied onto messenger RNA
- Occurs in the nucleus
- DNA $\longrightarrow$ mRNA

Translation

- Process by which information encoded in mRNA is used to assemble a protein at a ribosome
- Occurs on a Ribosome
- mRNA $\longrightarrow$ protein