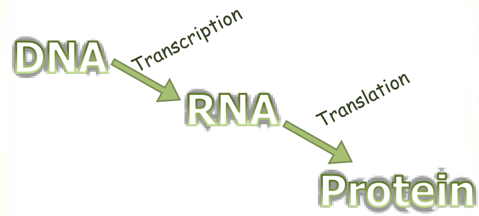
Protein Synthesis

Central Dogma Of Biology



Gene Expression

- Gene = portion of DNA that codes for a product
- Gene Expression
  1. Transcription: DNA → RNA
  2. Translation: RNA → amino acid sequence → protein shape → protein function

Flow of Information

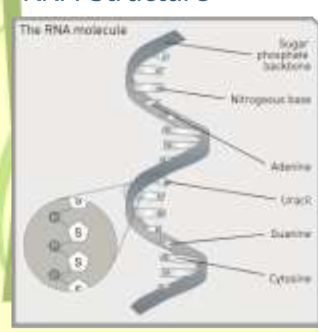
- DNA <u>cannot</u> leave nucleus
- DNA copies instructions into RNA (transcription)
- RNA leaves nucleus with instructions
- RNA carries instructions to ribosome
- Ribosome and RNA use instructions to make protein (translation)

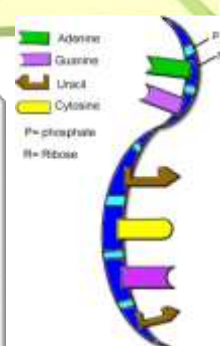
DNA vs RNA

DNA
- Deoxyribonucleic Acid
- Double stranded
- Long
- Deoxyribose
- A, T, C, G

RNA
- Ribonucleic Acid
- Single stranded
- Short
- Ribose
- A, U, C, G

RNA Structure

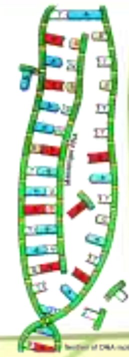




Types of RNA

- Messenger RNA (mRNA)
  - Carries information from DNA to ribosome
- Ribosomal RNA (rRNA)
  - Component of ribosomes; forms peptide bonds
- Transfer RNA (tRNA)
  - Transports amino acids to ribosomes to be used in proteins

Transcription



- Making an RNA copy of a piece of DNA (a gene)
- Location: nucleus (DNA can't leave)
- Enzyme: RNA Polymerase

Transcription

- DNA unzips (like replication)
- RNA nucleotides pair with complementary DNA nucleotides
  - RNA Polymerase
  - A ⇨ T, C ⇨ G, G ⇨ C, U ⇨ A
- When finished, RNA leaves nucleus and DNA zips up

Transcription

- DNA template:
- ATG GTC ATA TAG
- RNA:

Now YOU TRY!!

DNA Base	RNA Base
A	
T	
G	
C	
A	
G	
C	

Practice

Complementary DNA	DNA Template	RNA
1. CTA GTA CAG GTA		
2.	TAG CTG CGG ACA	
3.		GGA UGC AUA GUA
4.	GCT ATA CGA CTC	
5. ATA CGA ATC CGA		
6.		GUA CAG CGA UGC

✸ Only the DNA template is transcribed ✸

Practice

	DNA Sequence	RNA
DNA Template	GGT ATG CTA CGC	
Complementary DNA	CCA TAC GAT GCG	

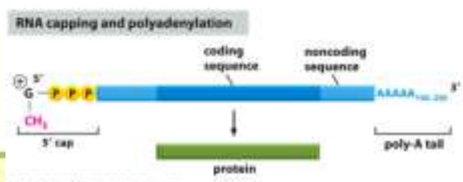
- Does it really matter which strand is transcribed?
  - Transcribe both the Complementary DNA and the DNA template
  - Does it make a difference in the RNA produced?
  - Will it make a difference in the protein that will be produced from the transcribed RNA?

Is the mRNA ready to use?

- Depends:
  - Yes for prokaryotes
  - No for eukaryotes
    - Called pre-mRNA
    - Needs processing

RNA Processing

- Capping: 5′ end
- Poly-A tail: 3′ end
- Splicing: removal of bases (introns)



Remember…

- The goal is to take the information in DNA and build a PROTEIN….
- DNA → gene→ mRNA→ amino acid sequence→ protein shape → protein function

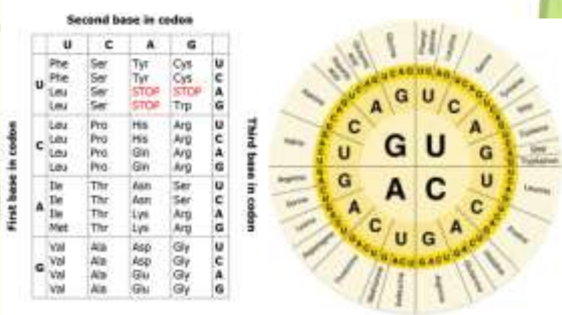
The Genetic Code

- How can nucleotides translate into amino acids (proteins)?

The Genetic Code

- Must be a 3 nucleotide code – Why?
- The code is redundant but specific
  - Each 3 nucleotide code (codon) codes for one and only one amino acid
  - An amino acid may have more than one codon

The Genetic Code

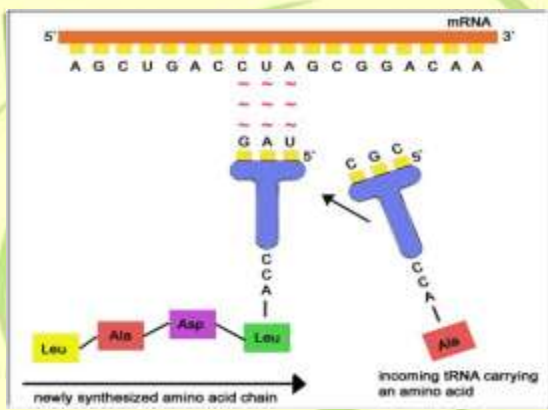


Second base in codon

First base in codon	U	C	A	G	Third base in codon
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	STOP	STOP	A
	Leu	Ser	STOP	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

Translation

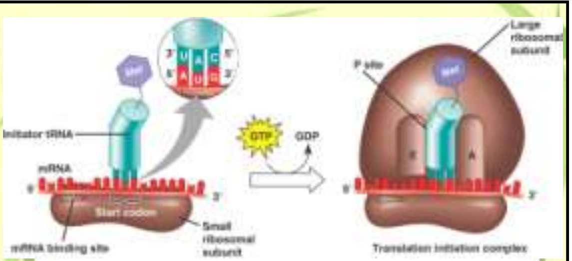
- From gene to protein
- Every three bases (codon) in mRNA = different amino acid



Translation

Initiation

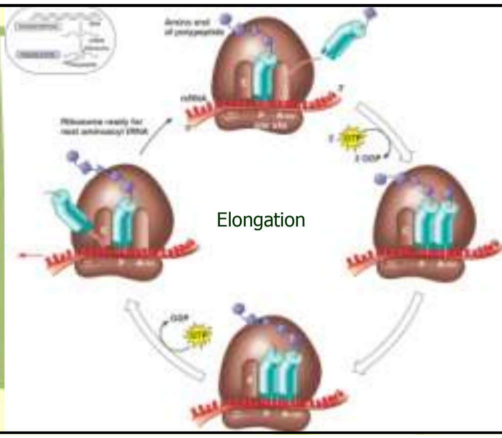
1. Ribosome attaches to mRNA
2. Translation begins with AUG = start = methionine (met)
3. tRNA with matching anticodon (UAC) attaches to mRNA



Translation

Elongation

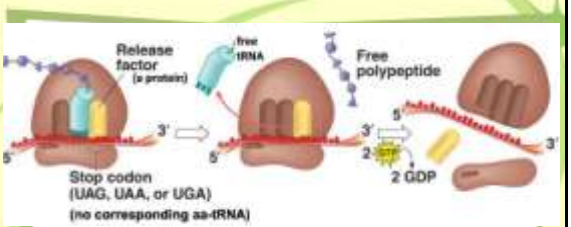
1. tRNA with amino acid for next codon attaches to mRNA
2. The amino acids bind together (peptide bond)
3. Ribosome slides down one codon and the free tRNA leaves
4. New tRNA binds to next codon



Translation

Termination

1. Process continues until stop codon
2. Release factor binds
3. Polypeptide is released
4. Ribosome-mRNA complex separates



Translation Practice

DNA	mRNA codon	tRNA anticodon	Amino acid
GCT			
TAG			
GAT			
CAT			
ATA			
TCA			
GAC