PROTEIN SYNTHESIS

Central Dogma of Biology

RNA (ribonucleic acid)

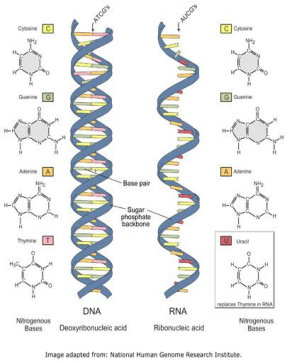
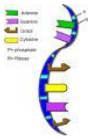


Image adapted from: National Human Genome Research Institute.

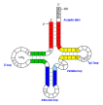
DIFFERENCES	
DNA	**RNA**
deoxyribose sugar	ribose sugar
double strand	single strand
bases A,T,C,G	bases A,U,C,G
found in: nucleus, mitochondria, chloroplasts	found in: nucleus, cytosol, ribososomes (2/3 rRNA, 1/3 protein)

3 types RNA

1. **messenger RNA** (mRNA)
   single uncoiled long strand
   - transmits DNA info during protein synthesis
   - serves as template to assemble amino acids



2. **transfer RNA** (t RNA)
   - carries amino acids to ribosome



3. **ribosomal RNA** (r RNA) makes up large part of ribosome
   - globular

PROTEIN SYNTHESIS/GENE EXPRESSION

Formation of proteins using information coded on DNA and carried out by RNA.

DNA: the president
RNA: the vice president
PROTEINS: the workers that carry out the jobs

Functions of Proteins
- cell structure, repair , and growth
- cell movement
- control biochemical pathways (enzymes)
- direct synthesis of lipids and carbohydrates

most important biomolecule for life

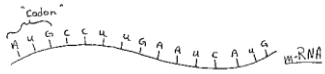
How is information necessary for creating proteins encoded in the RNA?

The genetic code from DNA is transcribed onto mRNA by **Codons**.

Code Word/Codon (triplet):
specific group of 3 successive bases on DNA and mRNA

- codes for a specific amino acid to be placed on the protein chain
- 20 biological amino acids, but more than 20 codons

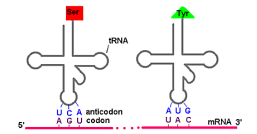
Like "genetic words"
DNA code words: ACA, GCA, TTA
RNA codons: TGU, CGU, AAU



How many combinations of code words/codons can we make from 4 bases?

64 combinations (4^3 = 64)

** each code word always codes for same amino acid**



The Genetic Code

2nd base in codon					
1st base in codon	U	C	A	G	3rd base in codon
U	Phe Phe Leu Leu	Ser Ser Ser Ser	Tyr Tyr STOP STOP	Cys Cys STOP Trp	U C A G
C	Leu Leu Leu Leu	Pro Pro Pro Pro	His His Gln Gln	Arg Arg Arg Arg	U C A G
A	Ile Ile Ile Met	Thr Thr Thr Thr	Asn Asn Lys Lys	Ser Ser Arg Arg	U C A G
G	Val Val Val Val	Ala Ala Ala Ala	Asp Asp Glu Glu	Gly Gly Gly Gly	U C A G

Ala: Alanine	Cys: Cysteine	Asp: Aspartic acid	Glu: Glutamic acid
Phe: Phenylalanine	Gly: Glycine	His: Histidine	Ile: Isoleucine
Lys: Lysine	Leu: Leucine	Met: Methionine	Asn: Asparagine
Pro: Proline	Gln: Glutamine	Arg: Arginine	Ser: Serine
Thr: Threonine	Val: Valine	Trp: Tryptophane	Tyr: Tyrosisne

How do these code words affect protein synthesis?

Order of code words

codes for

Order of amino acids

codes for

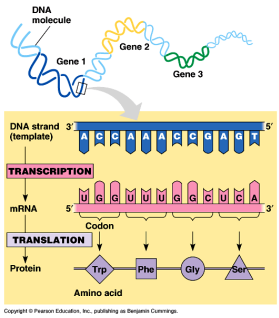
Specific type of protein

Stages of Protein Synthesis

- Building of proteins

2 Stages

1. Transcription (makes mRNA)
2. Translation (makes protein)

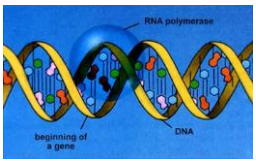


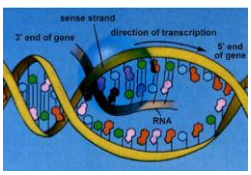
Steps of transcription (nucleus)

1. **Initiation**

A. the part of the DNA to be transcribed unzips

start codon: AUG
always codes for methionine



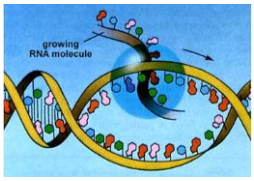


2. **Elongation**

A. Complementary nucleotides are added to the end of RNA

B. phosphate and sugar groups join to each nucleotide

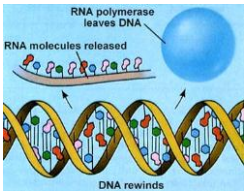
C. once RNA nucleotides are attached to DNA chain, codons are in proper order



3. Termination

A. Messenger RNA is made until a stop codon is reached.

- **stop codons:**
  UAA, UAG, UGA



B. RNA chain is bonded together

C. Newly formed m RNA goes into cytoplasm to ribosomes

D. DNA becomes double helix again

transcription animation

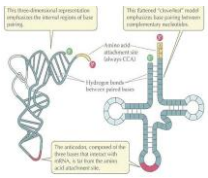
II. Translation (in cytoplasm at ribosome)

- process whereby protein is synthesized (created) from mRNA
- newly synthesized mRNA moves from nucleus to ribosome in cytoplasm
- gene has 100x more nucleotides than the protein it makes

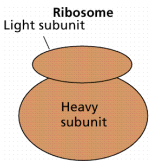
Ex: 100 a.a. = 300 nucleotides

2 Components of Translation

1. **Transfer RNA (t RNA)**
   - function: transfers amino acids to ribosome
     - 20 types – one for each amino acid (specific for each a.a.)
     - found in cytosol



2. **Ribosome**
   - 2 subunits make up ribosome
   - normally apart in cytoplasm, come together during protein synthesis

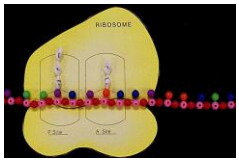


Steps of translation

1. **Initiation**

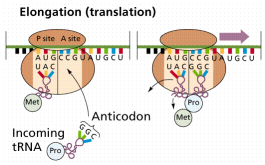
A. subunits attach (ribosome ready for protein synthesis)

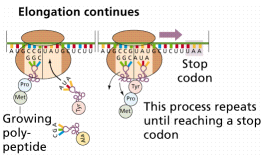
- sites: locations on ribosome where tRNA anticodons attach
  - A site
  - P site



C. **start codon (AUG)** will be at the site on mRNA where this occurs

** anticodon on first tRNA will always be **UAC**, amino acid 1 will always be **methionine**



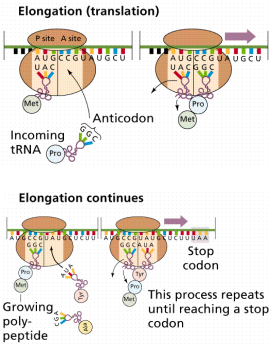


2. **Elongation**

A. t-RNA with a **specific anticodon** binds a **specific amino acid**.
   - This happens for several tRNAs and proper corresponding amino acids in the cytoplasm.
   - **ATP**: energy source used to bind the amino acid to the tRNA.

B. First tRNA binds to **P site**, second tRNA binds to **A site** (anticodons are **complementary** to mRNA codons)

Elongation, cont.



C. #1 a.a. joins to #2 a.a.

D. Ribosome moves down mRNA and first tRNA is released to be used over again

E. Amino acids continue to be added to protein chain thru same mechanism

3. Termination

A. **stop codon** is reached (UAA, UGA, or UAG).

C. subunits separate (can be used over again)

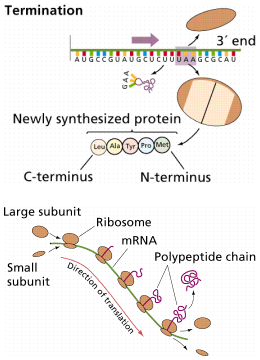
D. protein is released into cell

E. mRNA is broken down by cell (not be used again – only once)

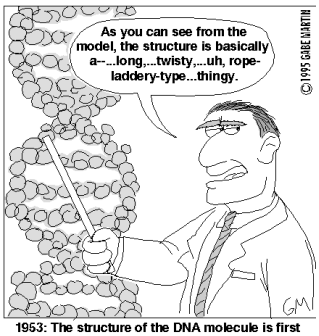
F. tRNA is released into cell (used over again)

Protein synthesis animation

Protein synthesis animation 2



Study, study, study!!!!!



1953: The structure of the DNA molecule is first described.