Information transfer in cells

OUTLINE OF NEXT TWO CLASSES

I. Biology … from an engineering perspective
    a. Evolution as the engineer
    b. Humans as engineers
    c. Structure & function
II. Information processing
    a. In computers
    b. Transcription and translation: DNA to RNA to protein
    c. Computers vs. cells
    d. Why is this a triplet code?
III. Protein structure and function
    a. general functions
    b. how can proteins be so diverse?
    c. diagrams/example of protein structure and function
    d. DNA sequence to protein function
    e. design of new proteins

KEY VOCABULARY

Amino Acid
Base (in DNA or RNA)
DNA Polymerase
Genetic Code
Ribosome
RNA Polymerase
Transcription
Translation

DISCUSSION: Information Handling

This exercise focuses on the basic issues that need to be addressed in handling source code (instructional information). Use a computer as the example to answer these questions. How does a computer handle information? What are the steps in each process?

1. Store information?

2. Copy information?

3. Retrieve information (and do something with it)?

DIAGRAM: DNA to Protein
Source: www.ornl.gov/info/ornlreview/v37_1_04/images/article12.jpg

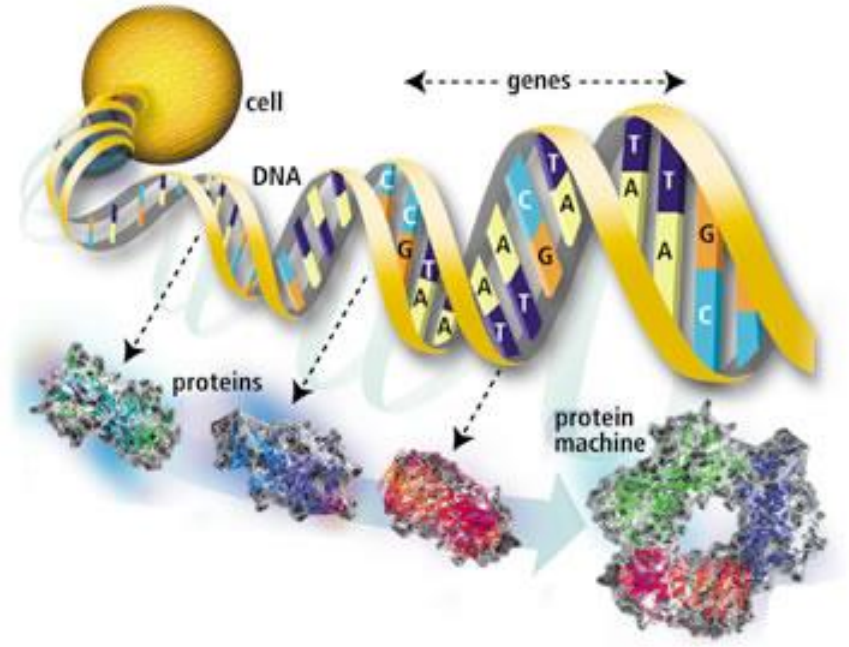
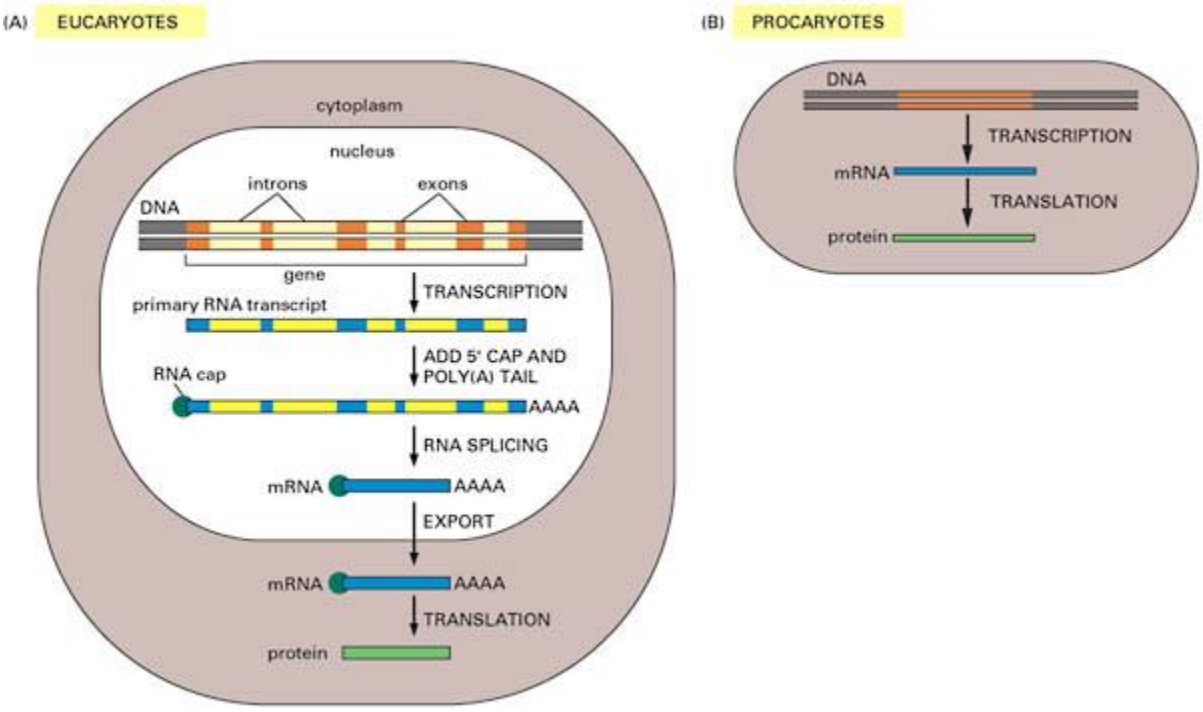


DIAGRAM: Prokaryote/Eukaryote Differences in Transcription and Translation
Source: *Molecular Biology of the Cell* by B. Alberts et al.



WORKSHEET: The Genetic Code

Using the genetic code table (below), fill in the following. For the amino acid sequence, start with the first ATG of the sense strand. (The sense strand is the one that is in the same orientation as the mRNA strand; the antisense strand is the one that gets copied into mRNA.) It helps to mark off the codons by threes.

DNA (5') G G A T A G C A T G A A A C C C G C A T A A (3') (sense strand)

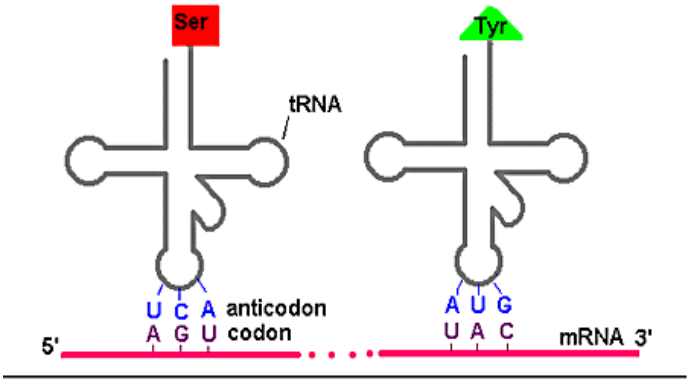
(3′) (5′) (antisense strand)

mRNA (5′)

amino acid

2. A coding region in an mRNA of 1600 bases would produce a polypeptide of _____ (how many?) amino acids.

The Genetic Code
Source of diagram: www-stat.stanford.edu/~susan/courses/s166/genetic.gif
In each case, the codon is in the mRNA and corresponds to the sequence in the coding strand of the DNA.



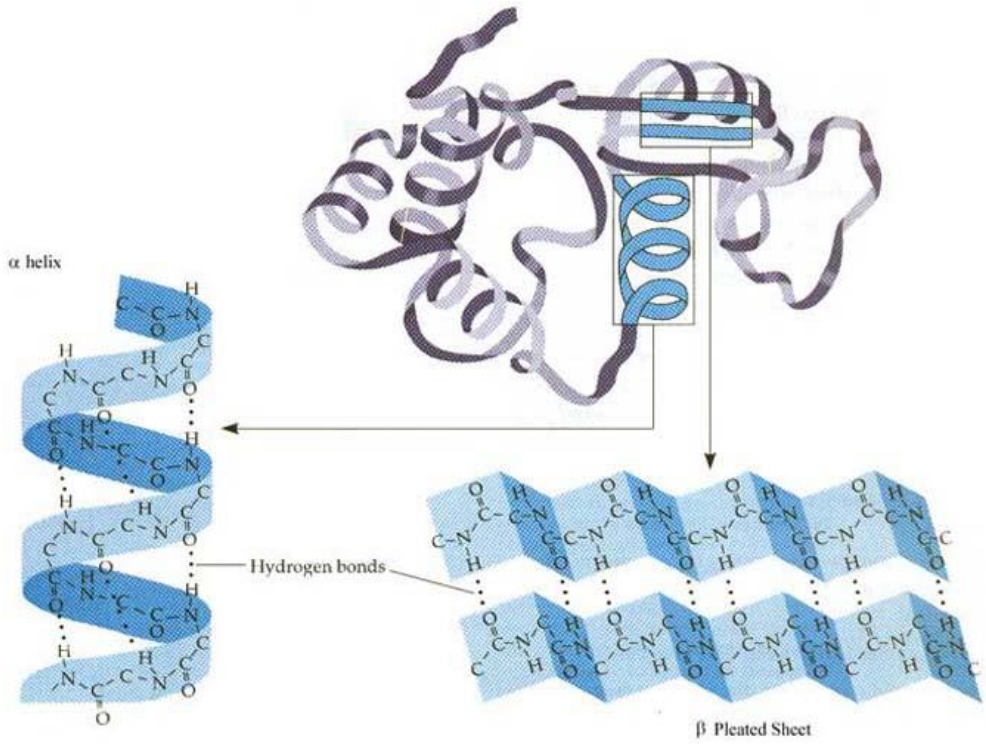
2nd base in codon

1st base in codon	U	C	A	G	3rd 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

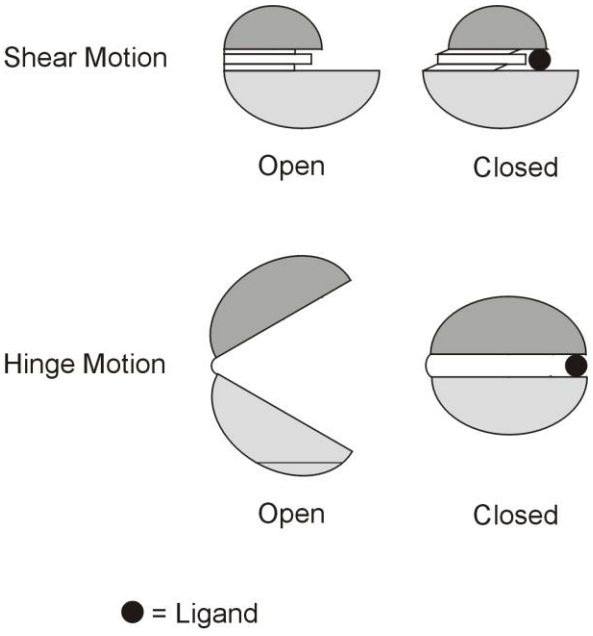
The Genetic Code

DIAGRAMS: Protein Structures and Functions

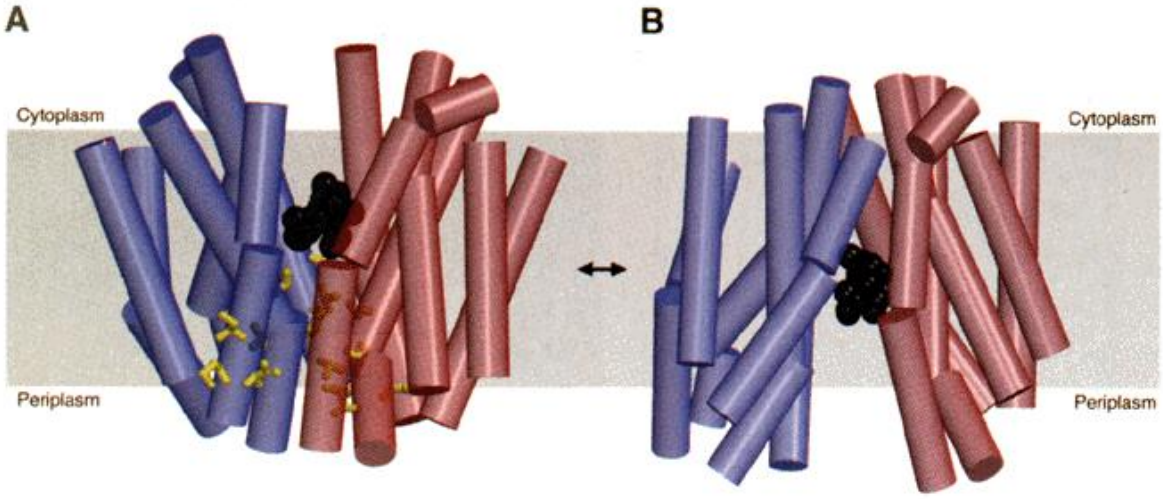
1. Secondary structure in proteins. Source: kvhs.nbed.nb.ca/gallant/biology/secondary_structure.jpg.



2. Cartoon demonstrating how the binding of a molecule (ligand) can cause a dramatic shift in the shape of a protein. Source: www.chemistry.mcmaster.ca/faculty/brennan/fastprotein.jpg.



3. The transporter lactose permease moves the sugar lactose (black cluster) from outside to inside via a hinge movement. Source: J. Abramson et al., *Science* **301**: 610-5, 2003.

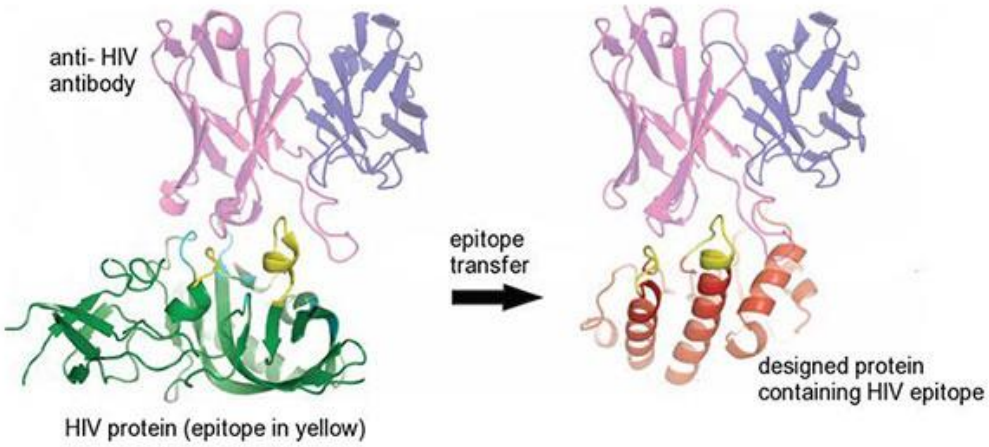


WORKSHEET: DNA Sequence to Protein Function

What is the relationship between

a. DNA sequence in a gene and amino acid sequence?
b. amino acid sequence and structure?
c. protein structure and protein function?
d. DNA sequence in a gene and protein function?

PROTEIN DESIGN: Example from David Baker's lab (UW)



Strategy for designing a virus-free vaccine for HIV (Image modified from: Azoitei M.L., Correia B.E. et al., *Science* 2011)