

# Biophysics: Lecture 1

Evolution

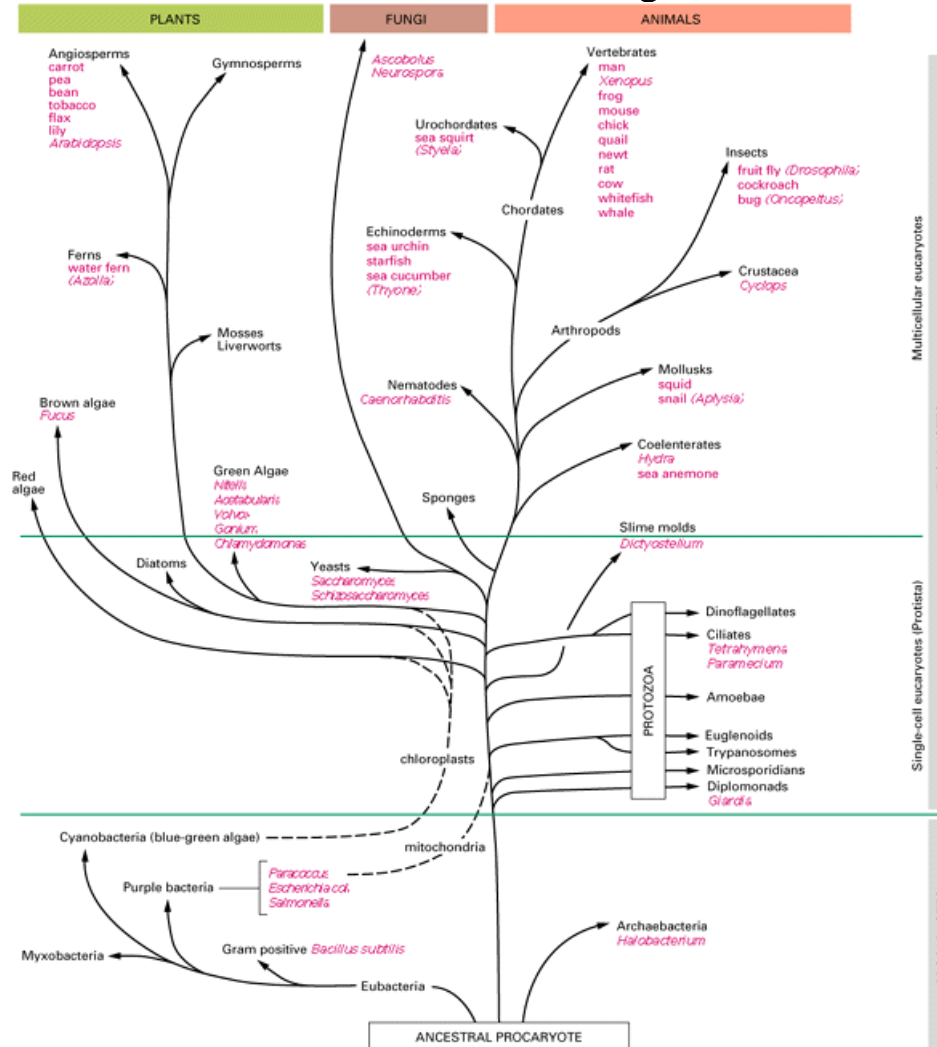
Cell

Biopolymers

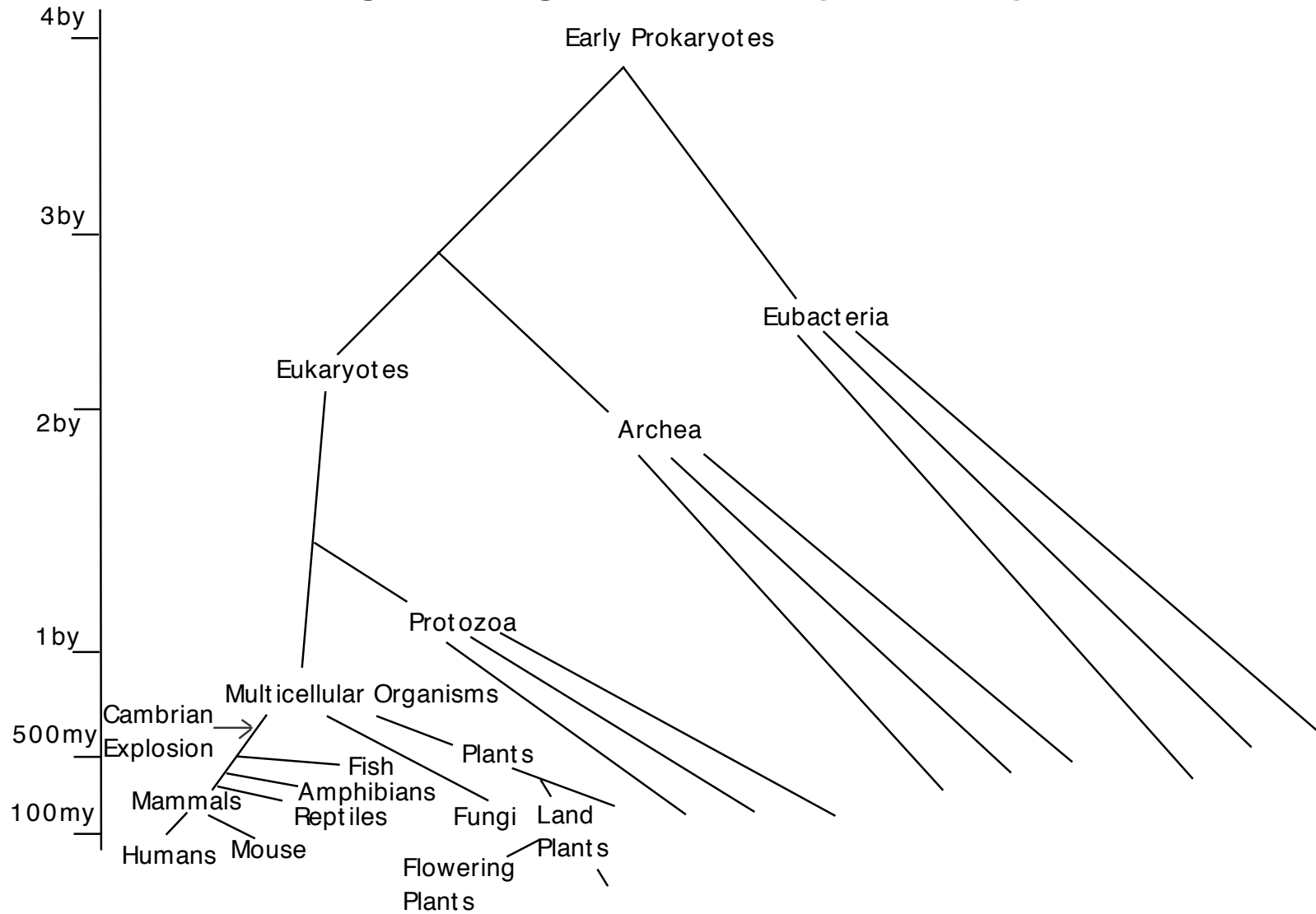
# Biology References

- Alberts et al., Molecular Biology of the Cell
- Lodish et al., Molecular Cell Biology
- Berg et al., Biochemistry

# Evolutionary Tree

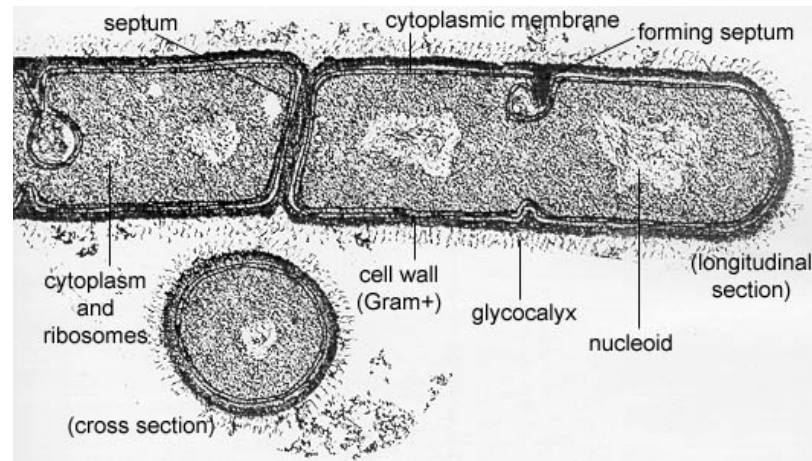


# Evolution Timescale

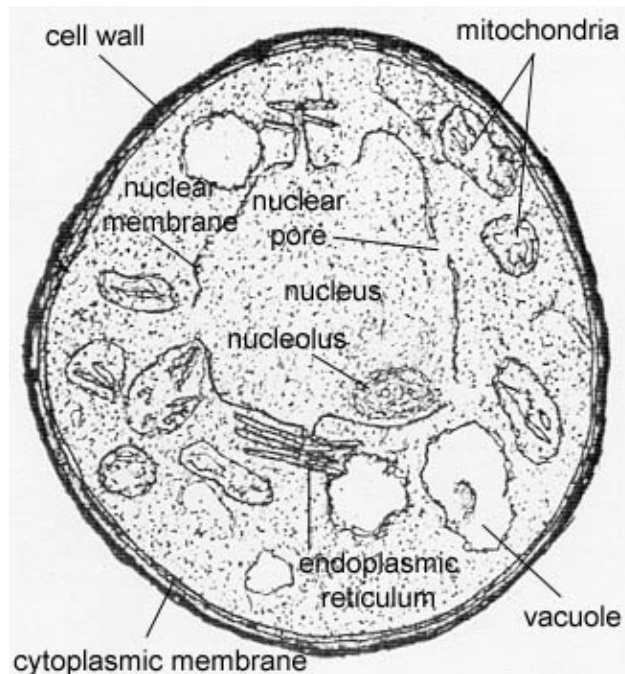


# Prokaryotes vs Eukaryotes: Cell

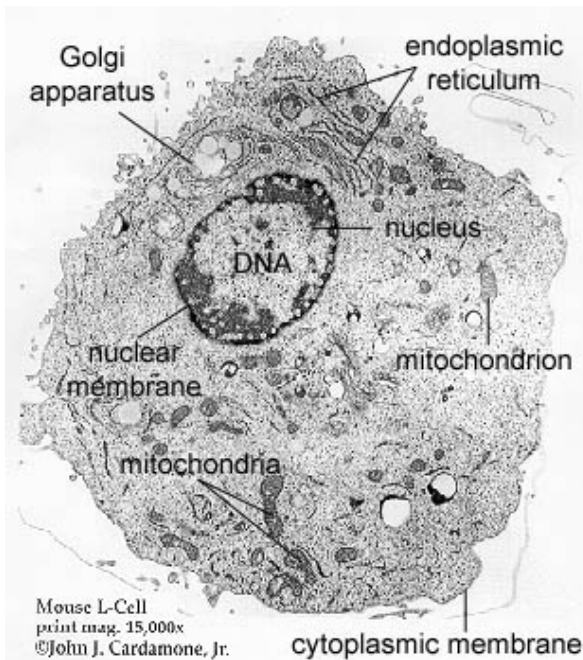
Bacillus  
megaterium



Candida  
albicans



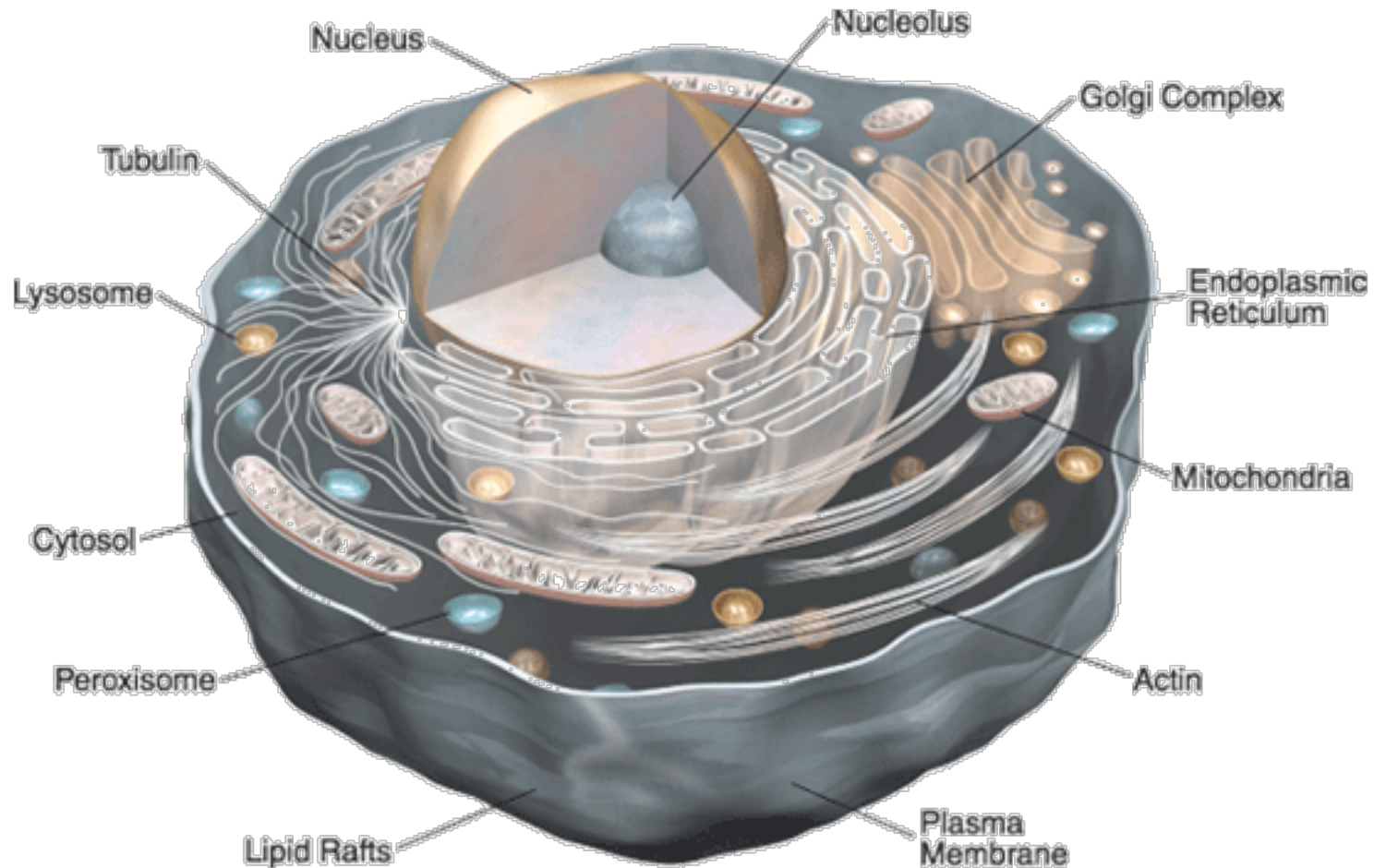
Mouse  
L-cell



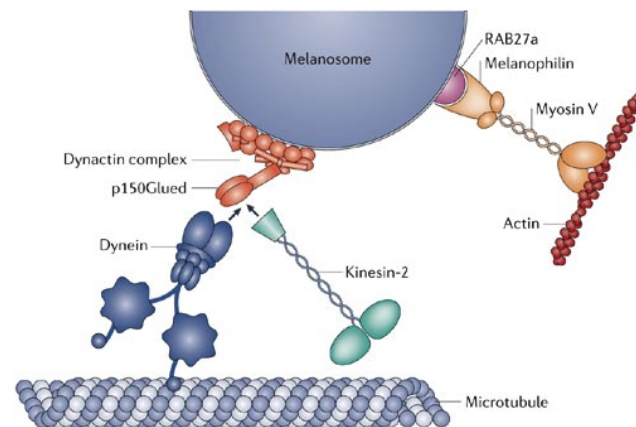
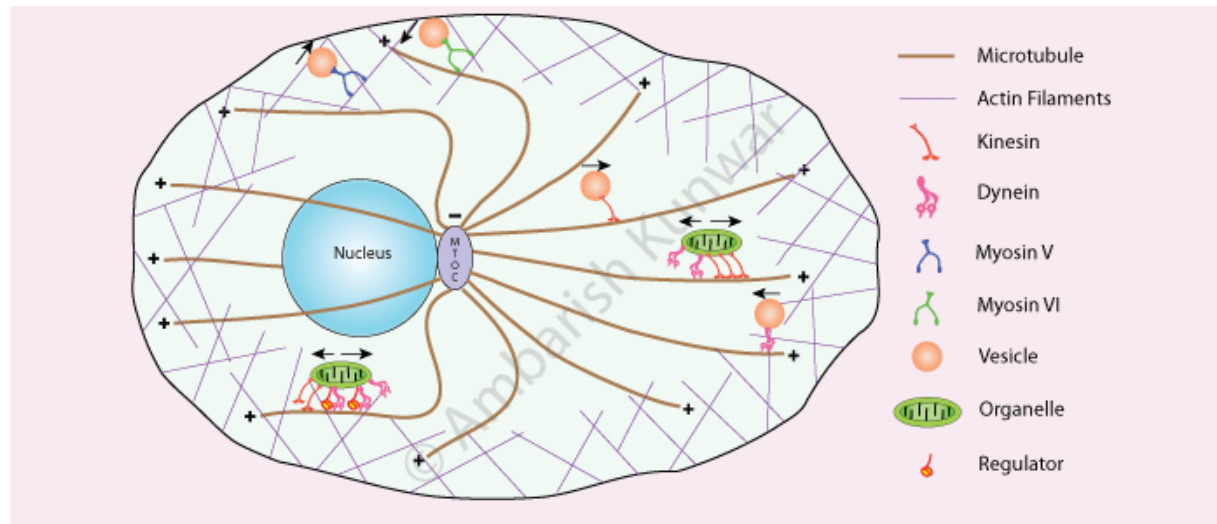
# Major Differences

Type	Prokaryote	Eukaryote
Size	0.1-10 microns	10-100 microns
Genome	circular DNA	DNA condensed in chromosomes
Organelles	None	Many organelles
Metabolism	Multiple strategies	Mostly oxydative
Internal membranes	None	Complex folded ER
Mobility	Flagella	Undulipodia

# Eukaryotic Cell Organelles

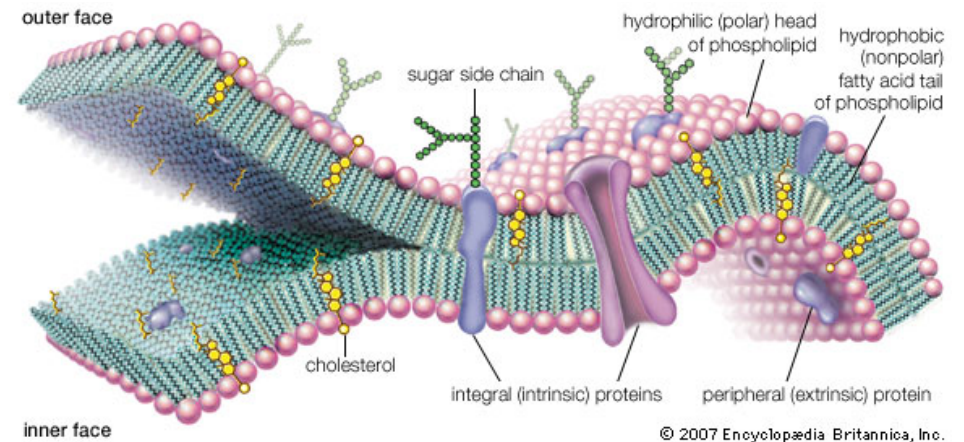
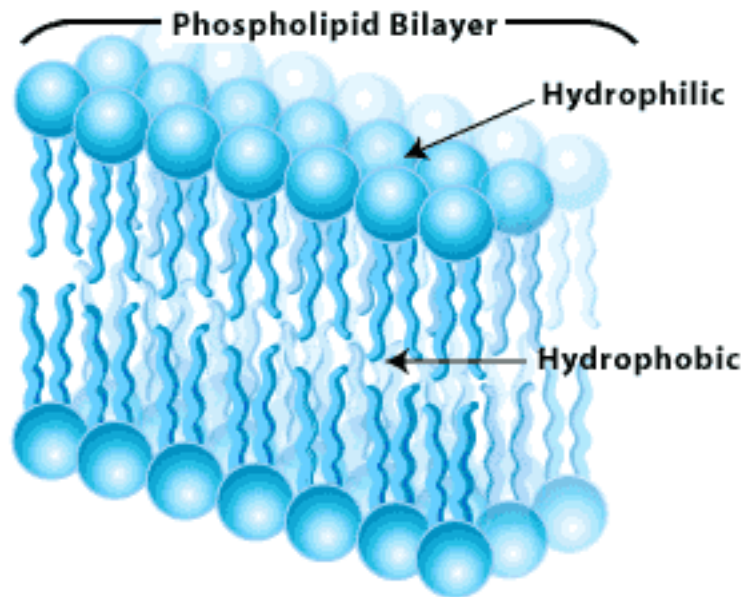


# Motor Proteins

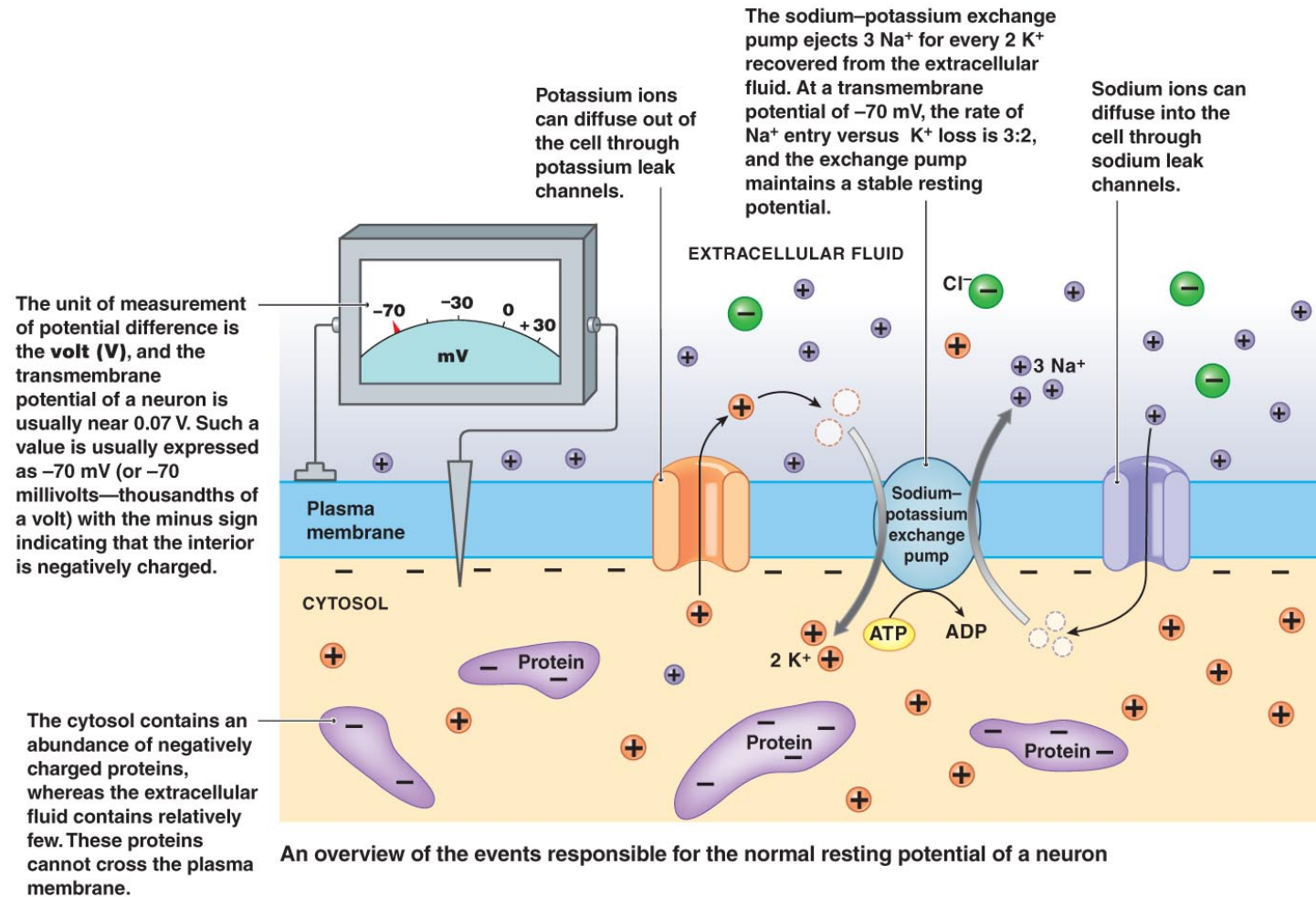




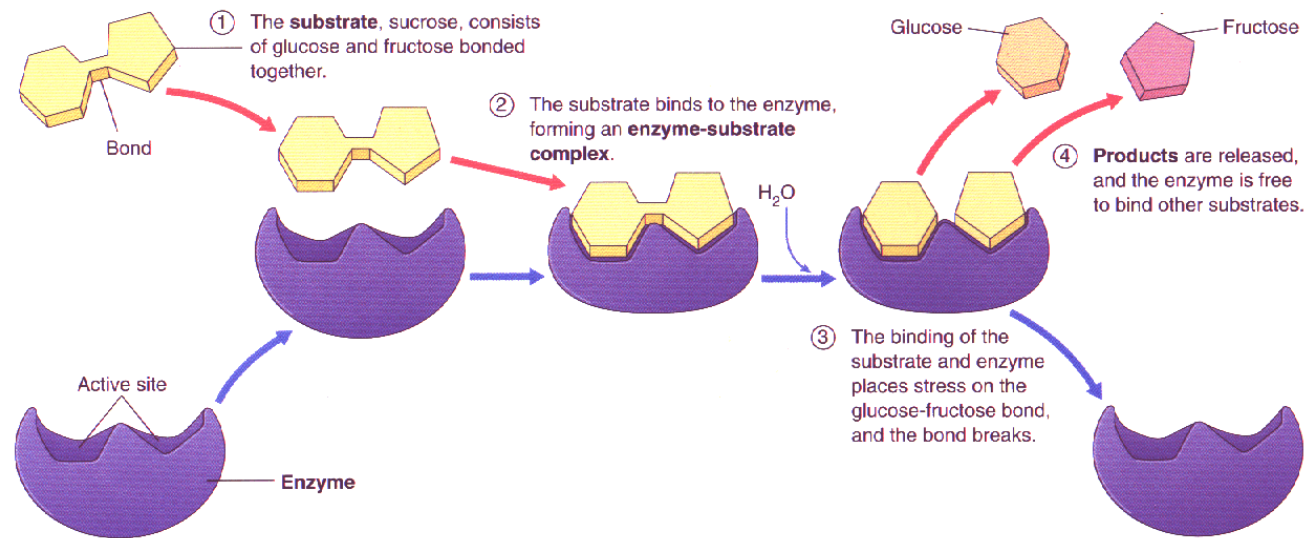
# Plasma Membrane



# Ionic Pumps and Channels

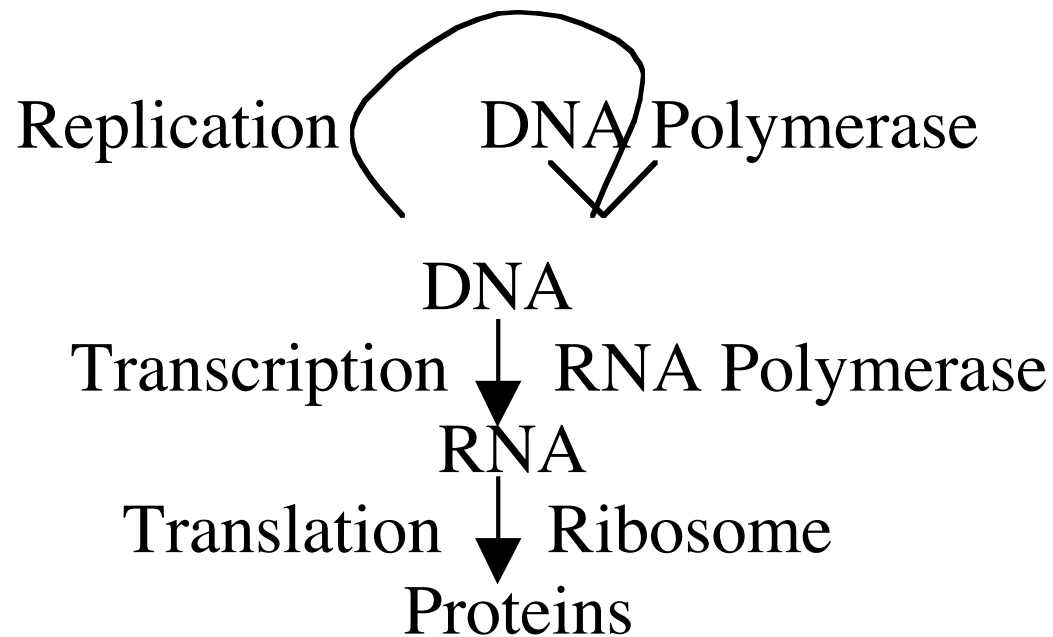


# Enzymes

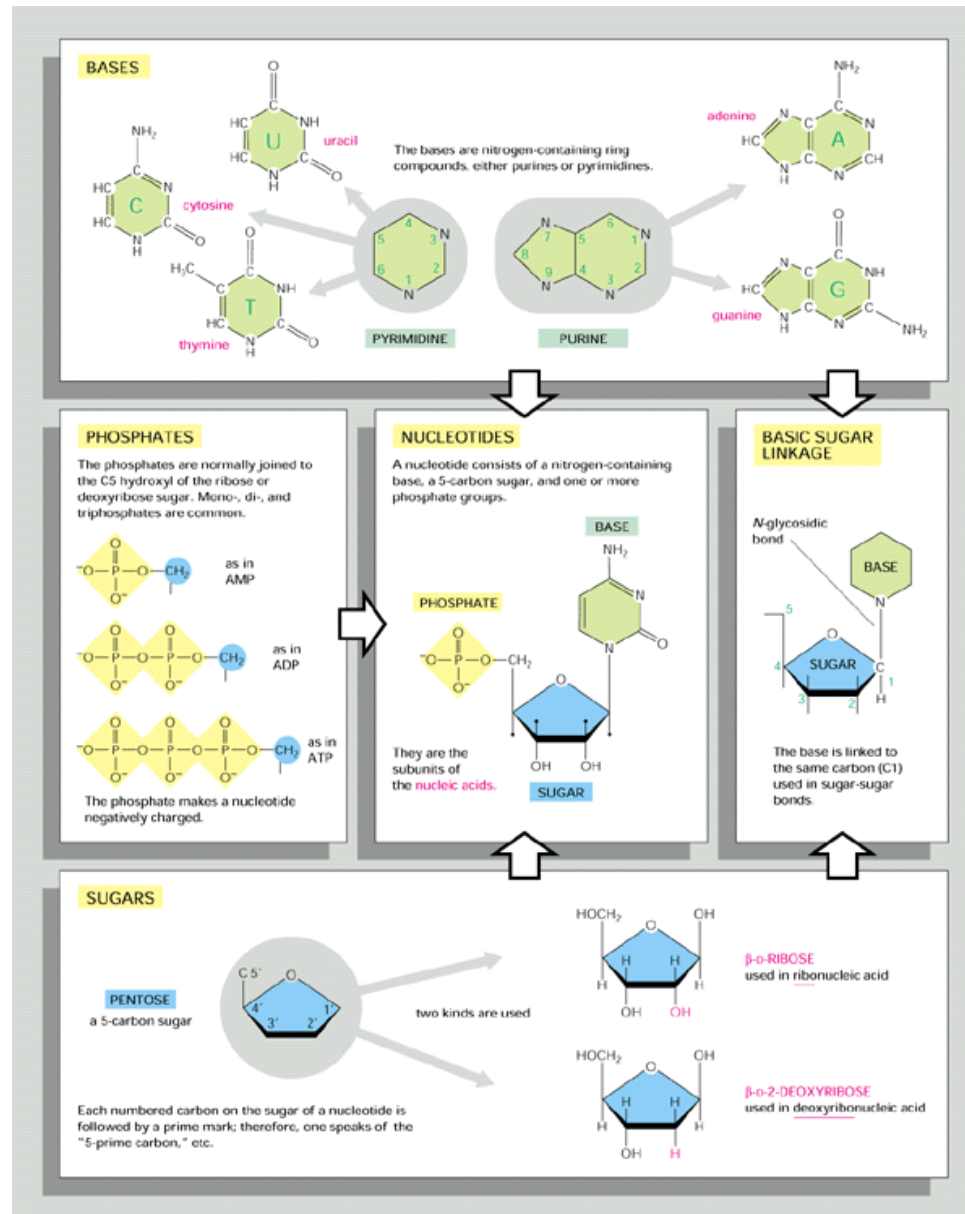


## Sucrase Activity

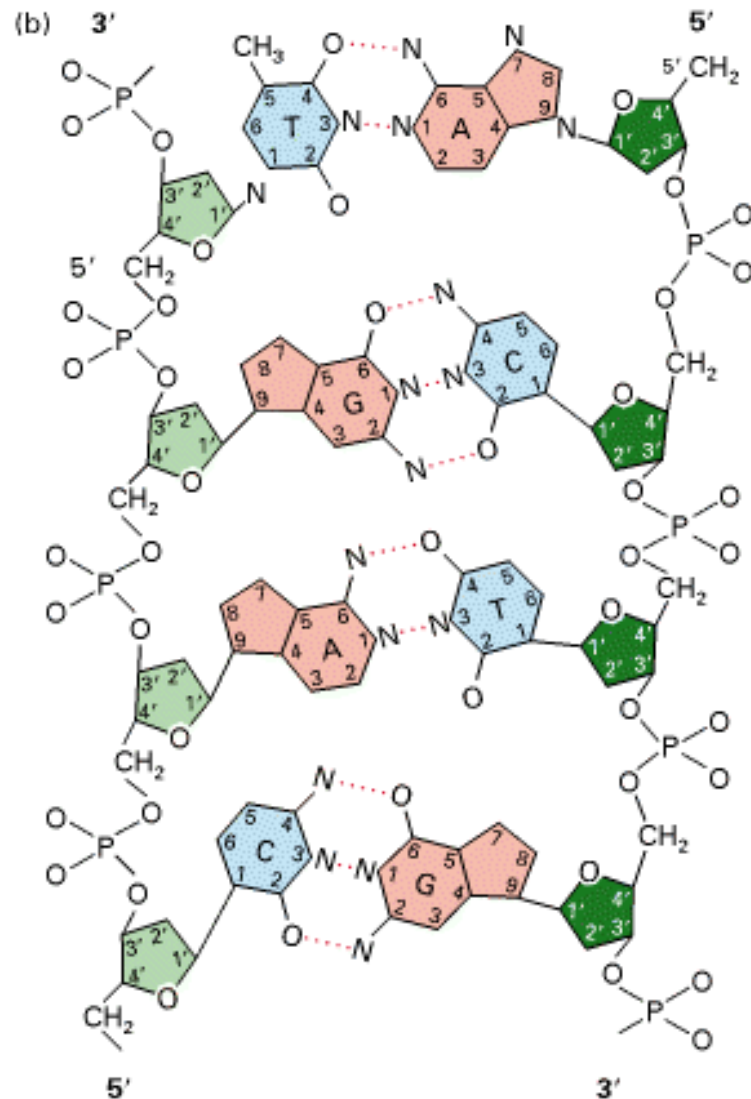
# Unity in Diversity: Basic Molecules and Processes



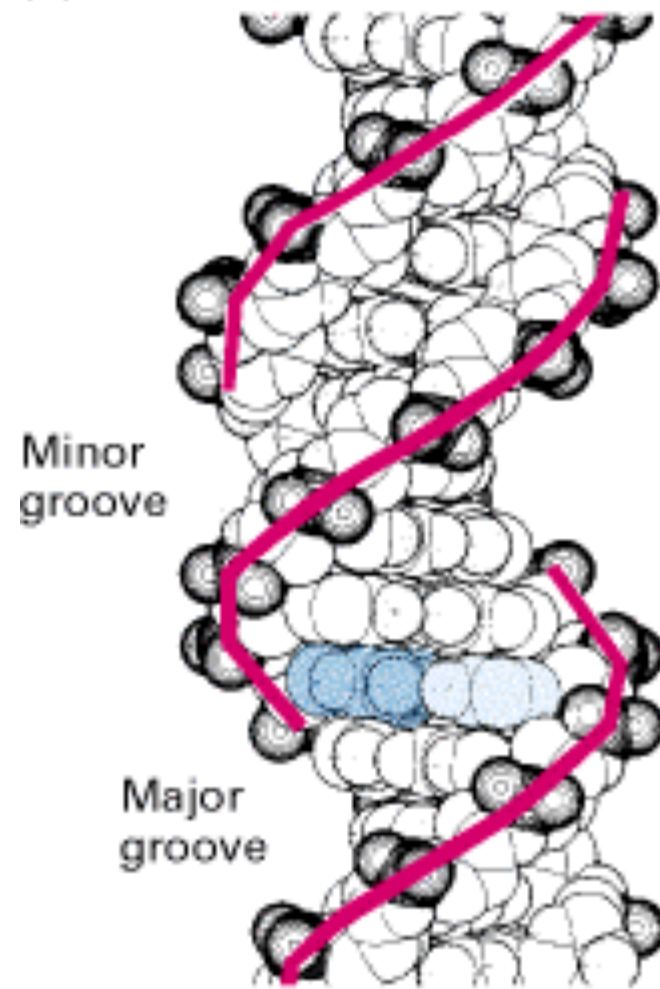
# Nucleic Acid Ingredients



# DNA Double Helix



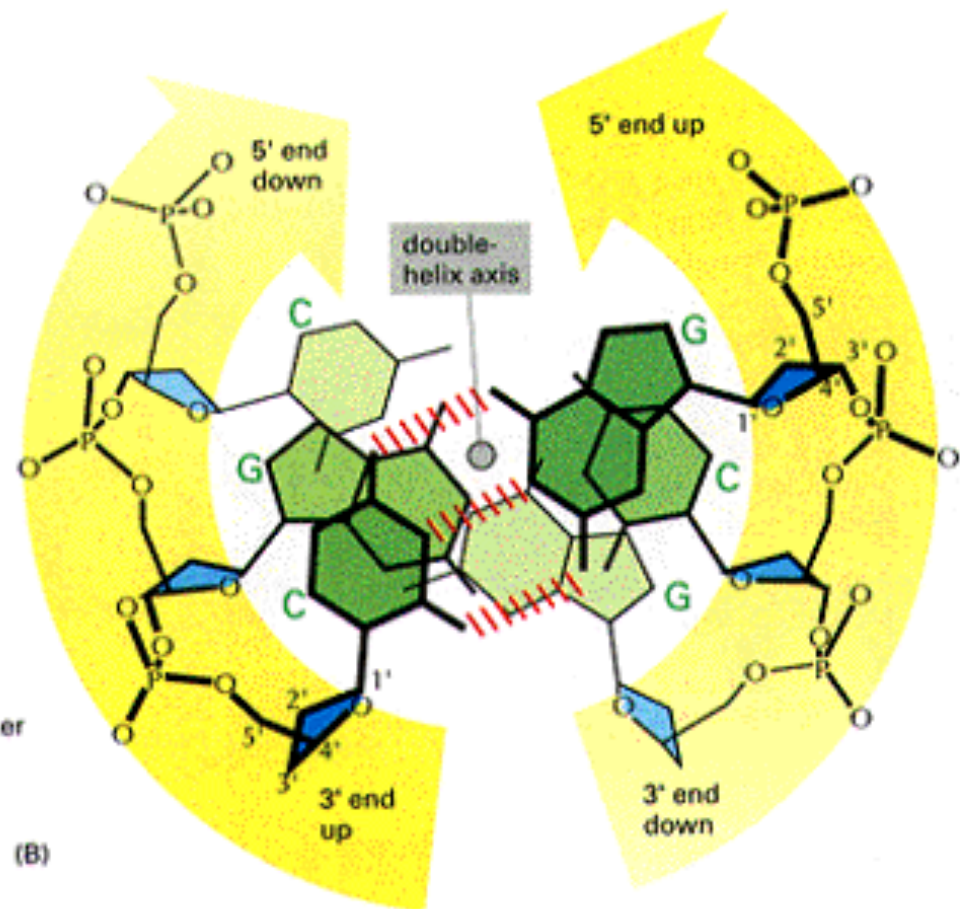
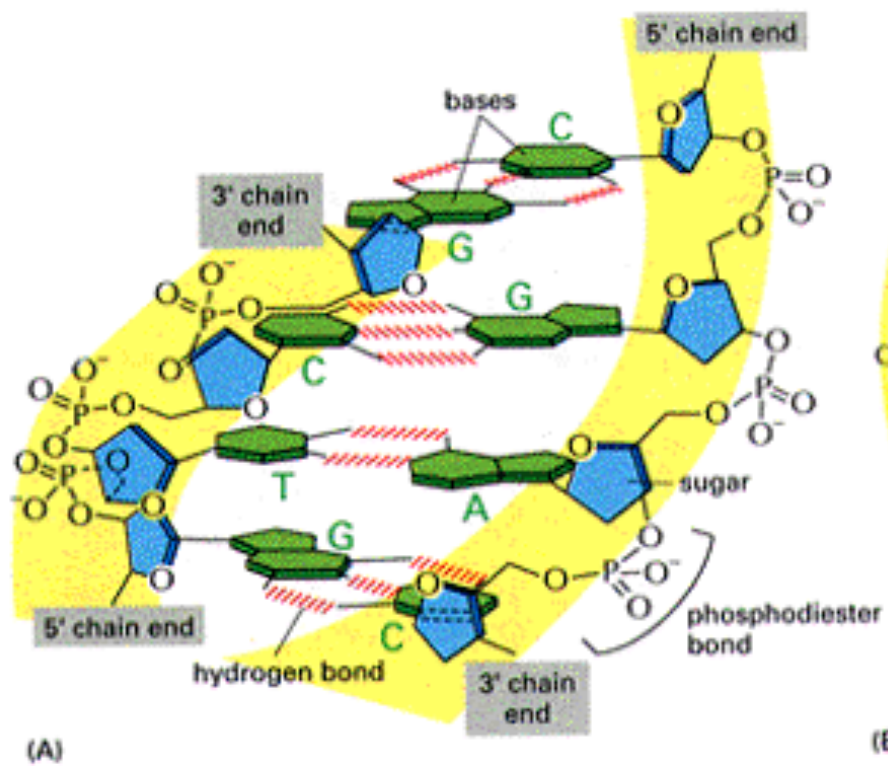
(a)



Normal B DNA



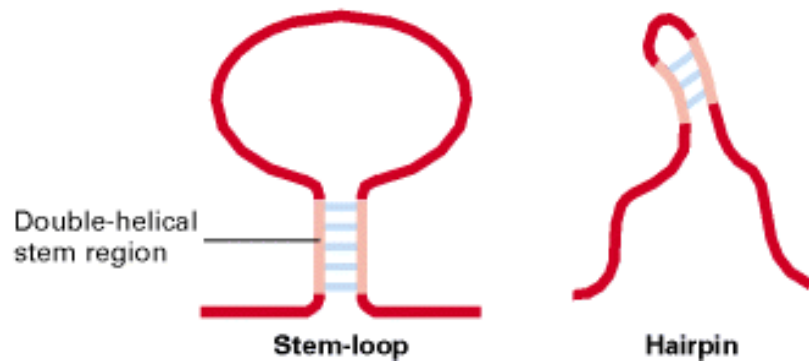
# Another Look



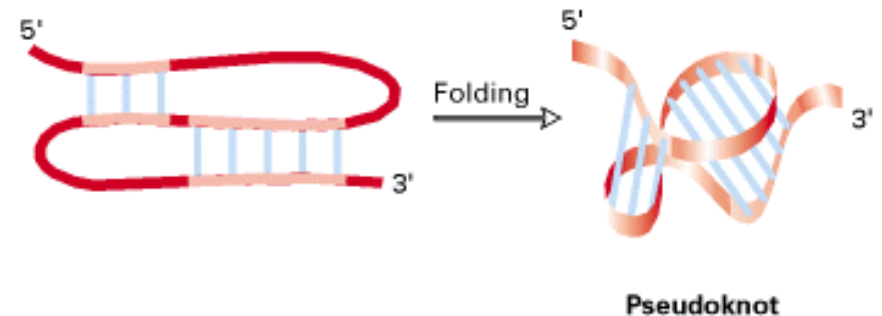
# RNA

- Typically single stranded
- 3dim structure depends upon how it folds on itself

(a) Secondary structure



(b) Tertiary structure





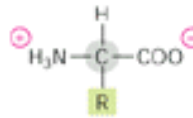
# Protein Ingredients

## THE AMINO ACID

The general formula of an amino acid is

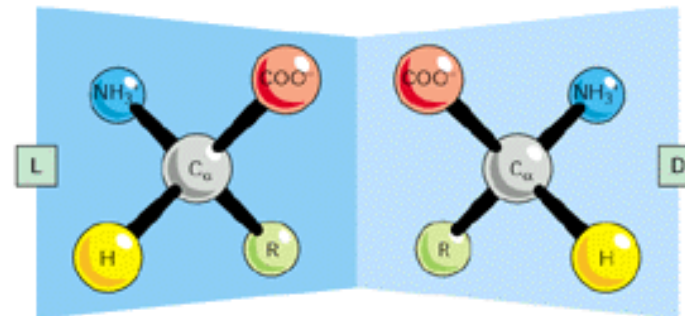


R is commonly one of 20 different side chains. At pH 7 both the amino and carboxyl groups are ionized.



## OPTICAL ISOMERS

The  $\alpha$ -carbon atom is asymmetric, which allows for two mirror image (or stereo-) isomers, D and L.

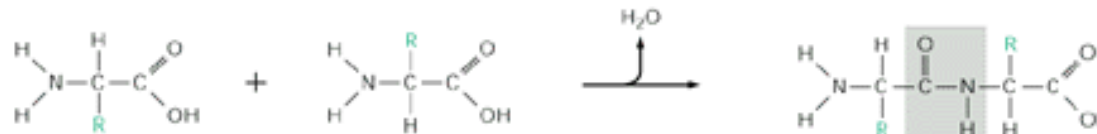


Proteins consist exclusively of L-amino acids.

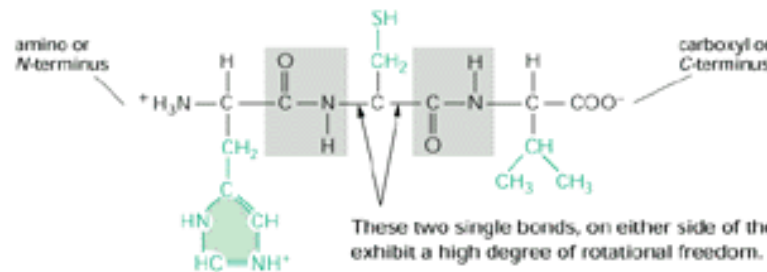
## PEPTIDE BONDS

Amino acids are commonly joined together by an amide linkage, called a peptide bond.

**peptide bond:** The four atoms in each gray box form a rigid planar unit. There is no freedom of rotation about the C—N bond.



**Proteins** are long polymers of amino acids linked by peptide bonds, and they are always written with the *N*-terminus toward the left. The sequence of this tripeptide is His Cys Val.



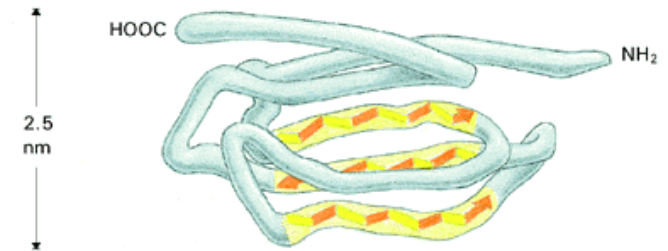
# Structural Motifs in Proteins

Black, Grey: Carbon

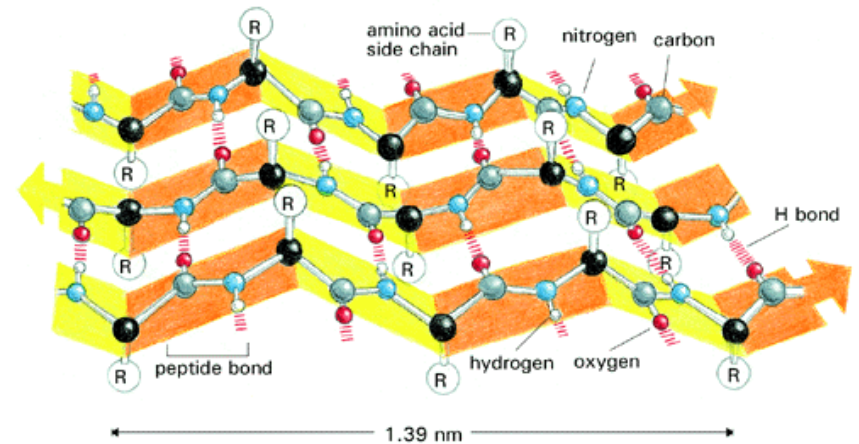
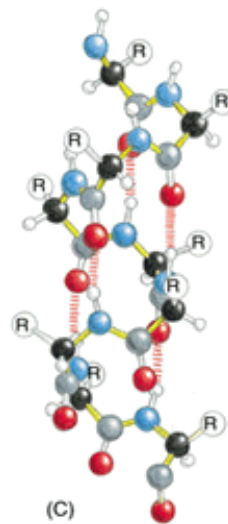
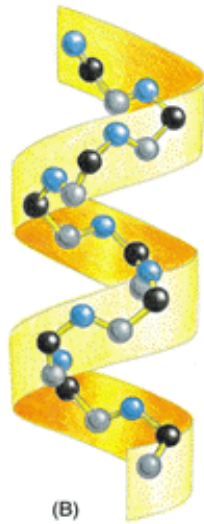
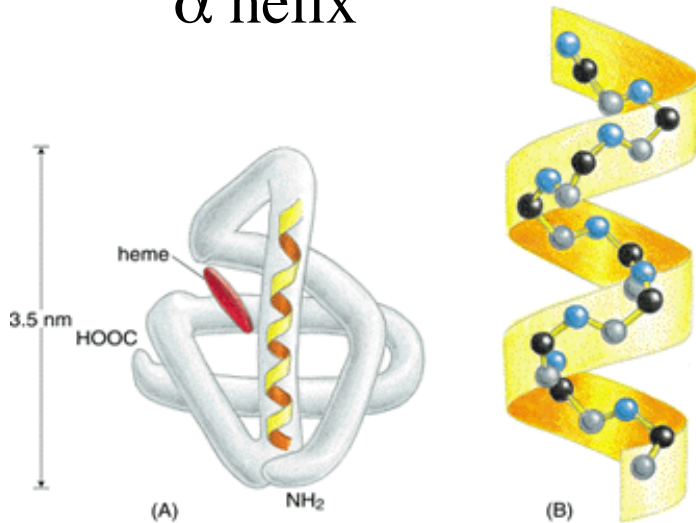
Blue: Nitrogen

Red: Oxygen

$\beta$  sheet



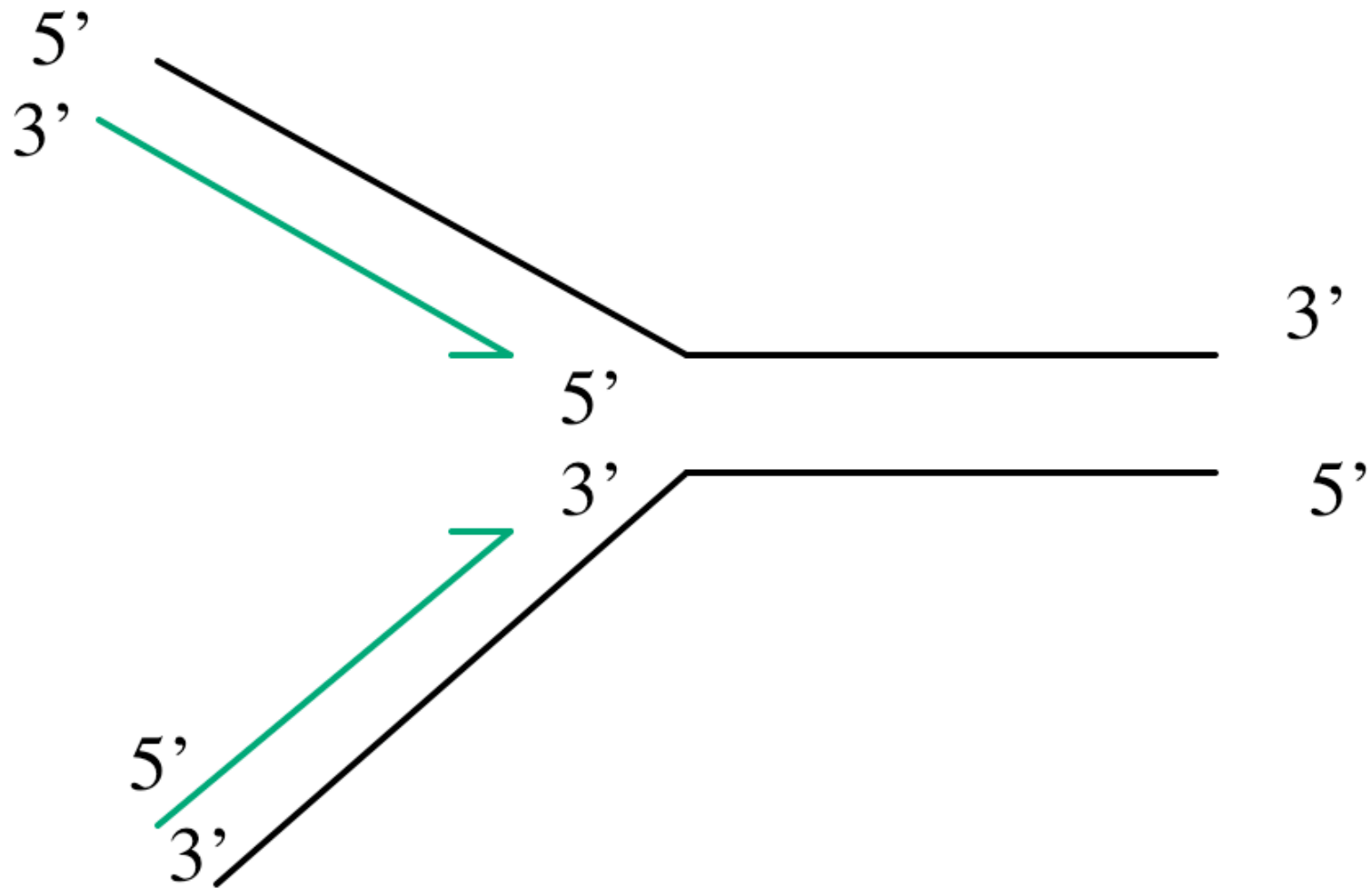
$\alpha$  helix



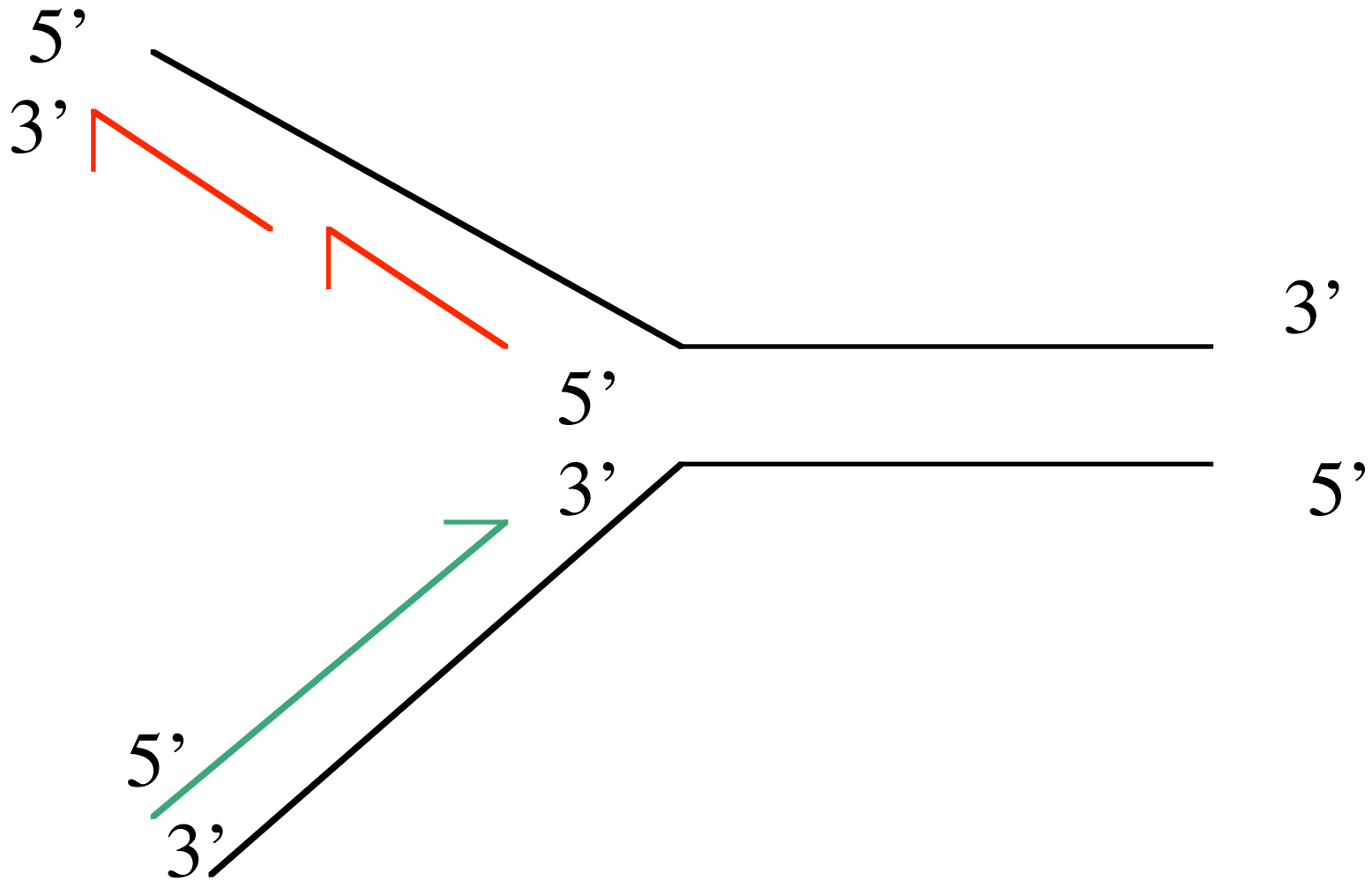
# Focus

- Central Dogma
- Central Genetic Processes: Transcription, Translation and Replication

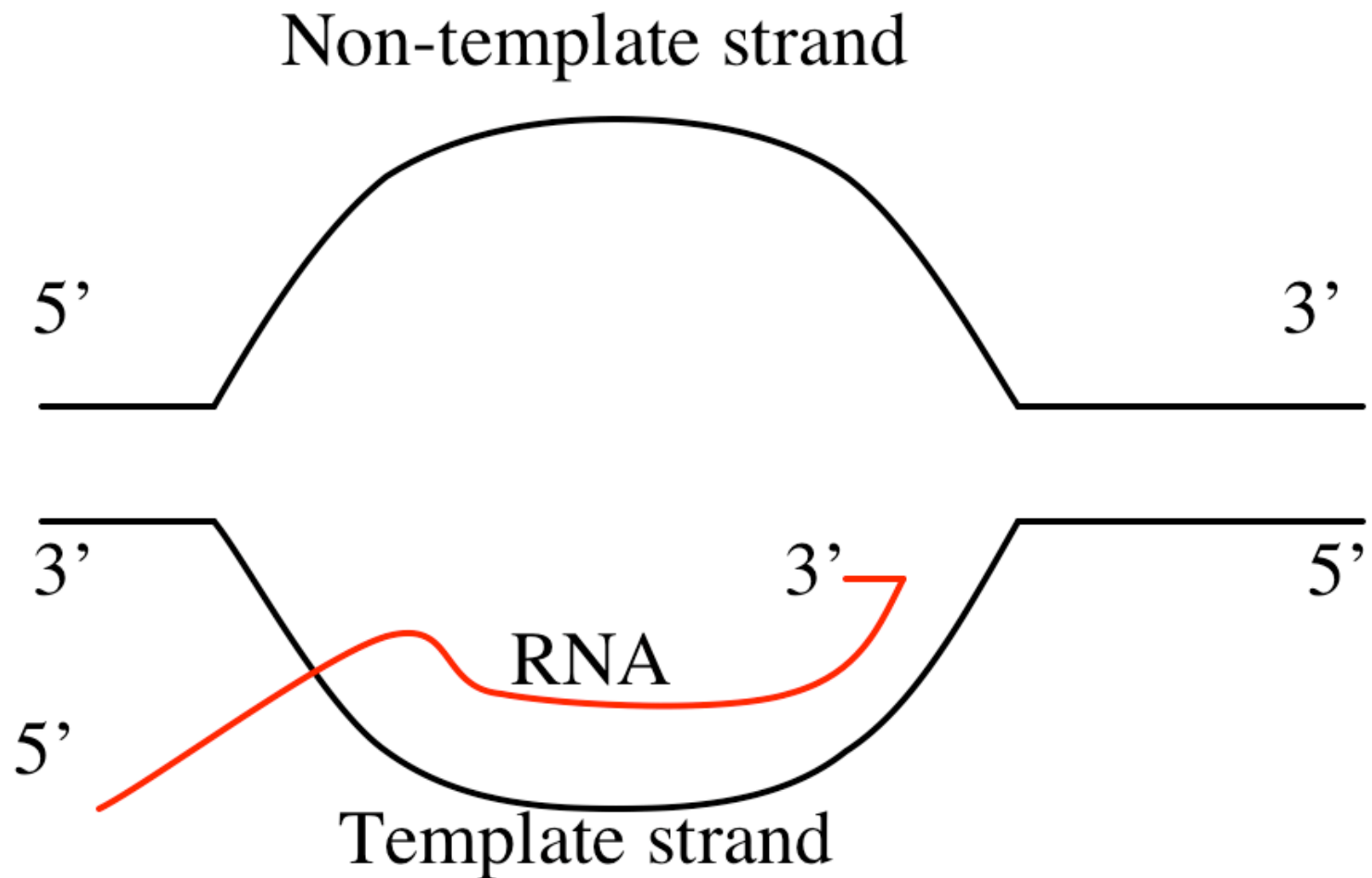
# Forbidden Route to Replication



# Replication



# Transcription



# Translation

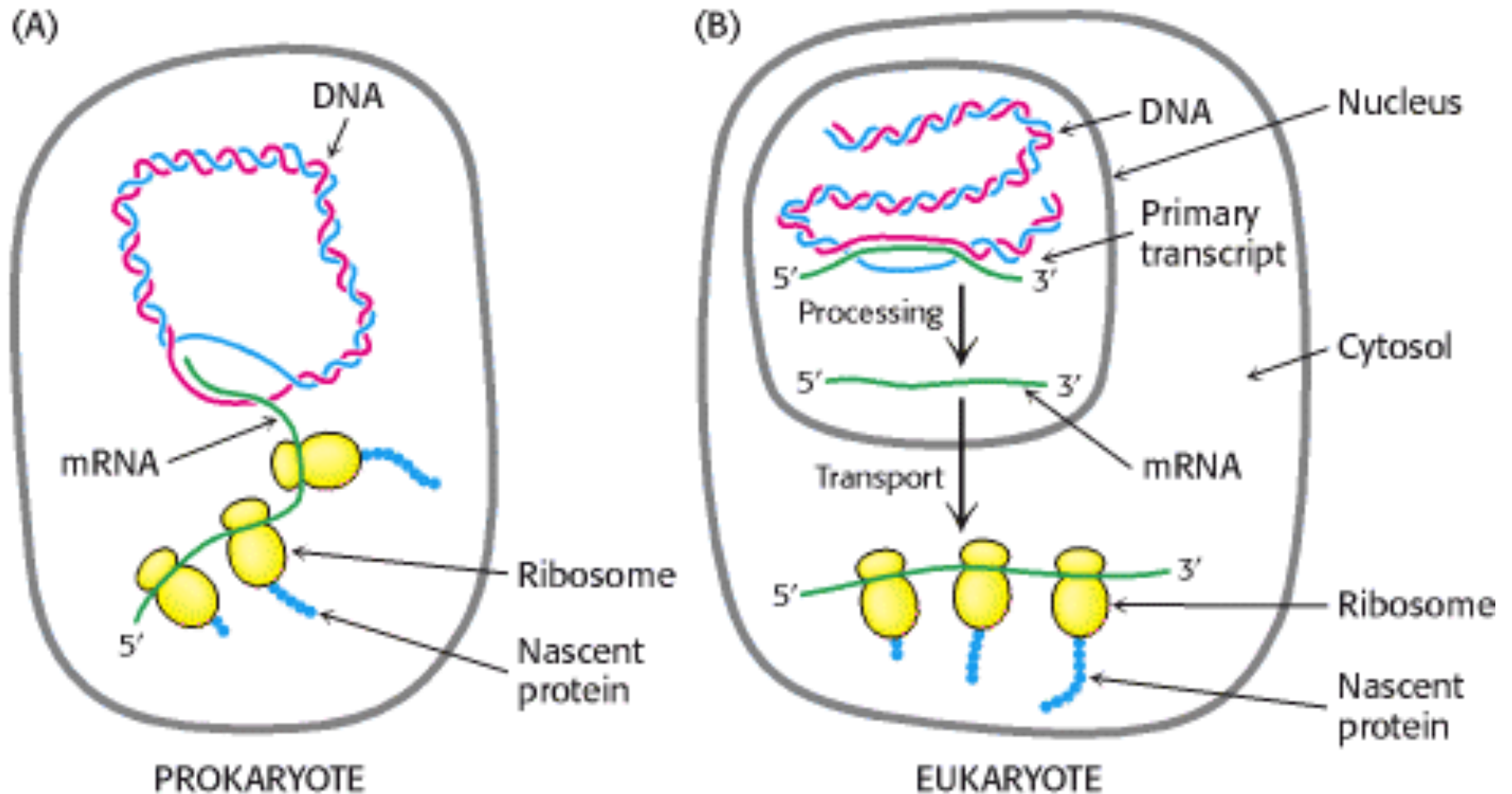


Diagram C illustrates the three-step process of tRNA translocation during translation. The ribosome is shown as a green structure with three sites: E (Exit), P (Peptidyl), and A (Aminoacyl). The mRNA sequence is GCACUGUUCUGGCAGAGA, with the 5' end on the left and the 3' end on the right. The tRNA in the E site has the anticodon AAG and carries the amino acids Phe and Ala. The tRNA in the A site has the anticodon ACC and carries the amino acid Trp. In step 1, the tRNA in the E site moves to the P site. In step 2, the tRNA in the A site moves to the E site. In step 3, the tRNA in the E site is released, and the tRNA in the A site remains in the P site.

GCA	AGA									UUA					AGC						
GCC	AGG						GGA			UUG					AGU						
GCG	CGA						GGC		AUA	CUA					UCA	ACA			GUA		
GCG	CGC	GAC	AAC	UGC	GAA	CAA	GGG	CAC	AUC	CUC	AAA				CCC	UCC	ACC		GUC	UAA	
GCU	CGU	GAU	AAU	UGU	GAG	CAG	GGU	CAU	AUU	CUG	AAG	AUG	UUC	CCG	UCG	ACG	UGG	UAC	GUG	UAG	
										CUU			UUU	CCU	UCU	ACU		GUU	UGA		
Ala	Arg	Asp	Asn	Cys	Glu	Gln	Gly	His	Ile	Leu	Lys	Met	Phe	Pro	Ser	Thr	Trp	Tyr	Val	stop	
A	R	D	N	C	E	Q	G	H	I	L	K	M	F	P	S	T	W	Y	V		



# Videos

<http://www.youtube.com/watch?v=4jtmOZaIvS0>  
[http://www.youtube.com/watch?v=41\\_Ne5mS2ls](http://www.youtube.com/watch?v=41_Ne5mS2ls)