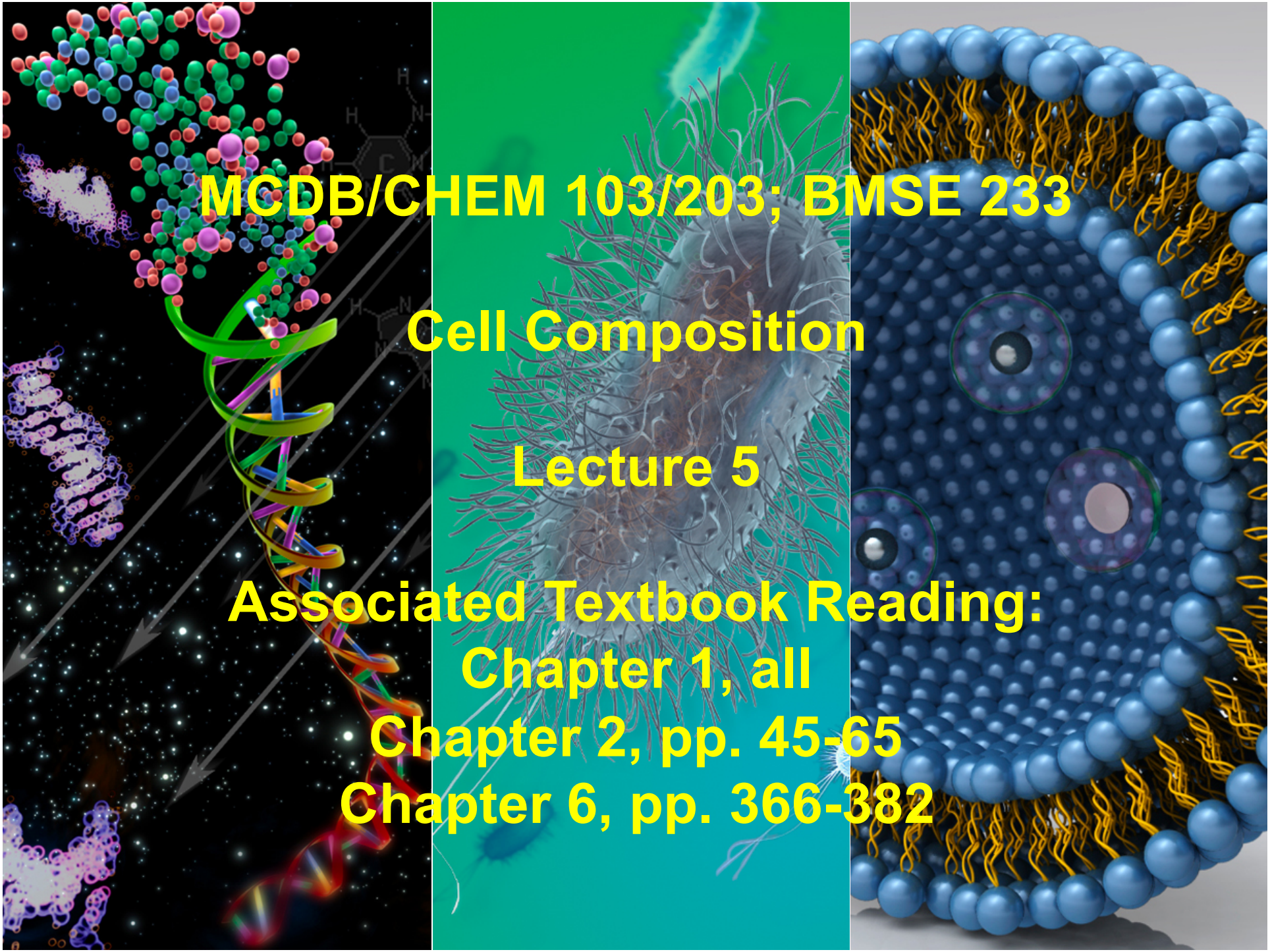


MCDB/CHEM 103/203; BMSE 233

Cell Composition

Lecture 5

Associated Textbook Reading:
Chapter 1, all
Chapter 2, pp. 45-65
Chapter 6, pp. 366-382

From DNA to RNA to Protein

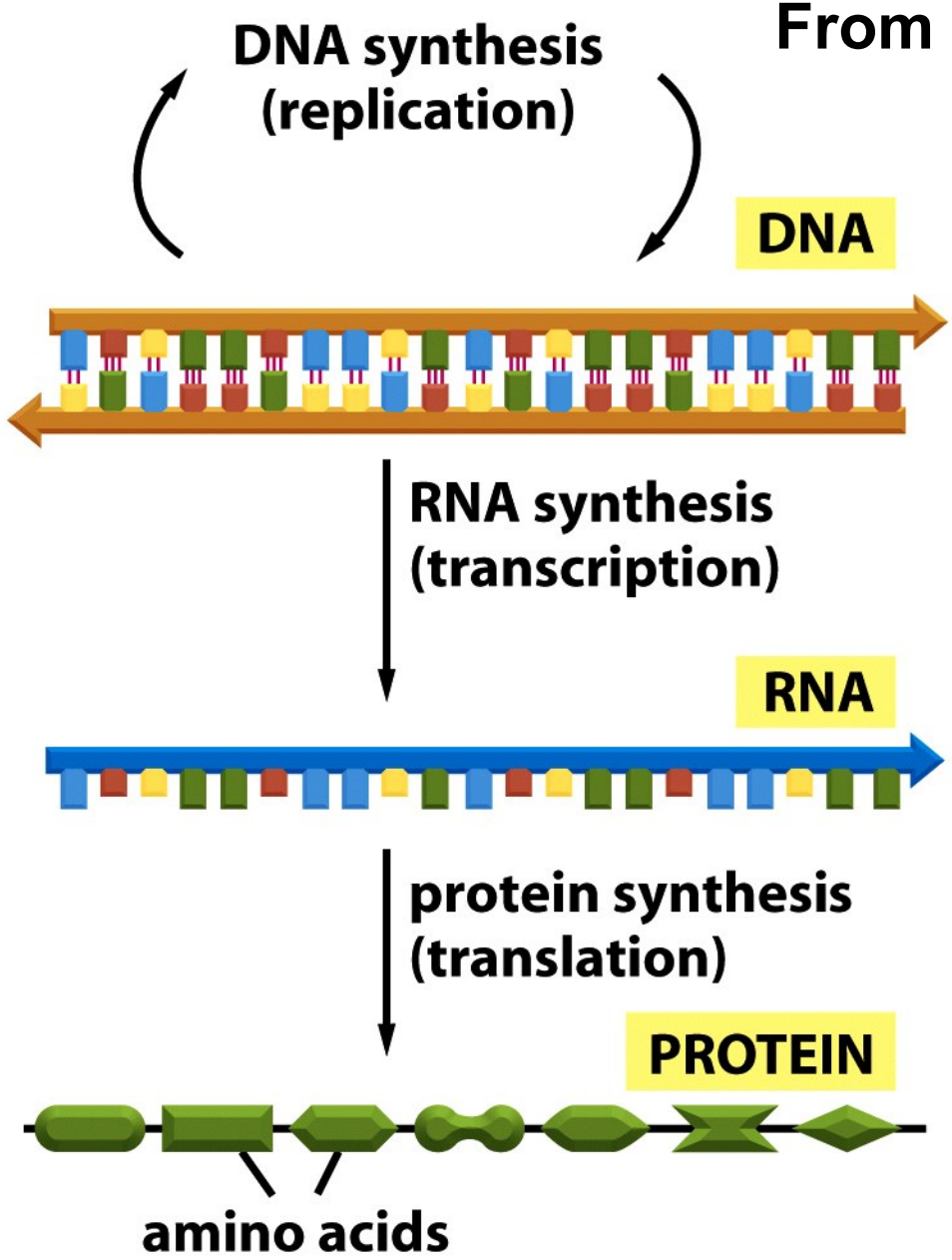
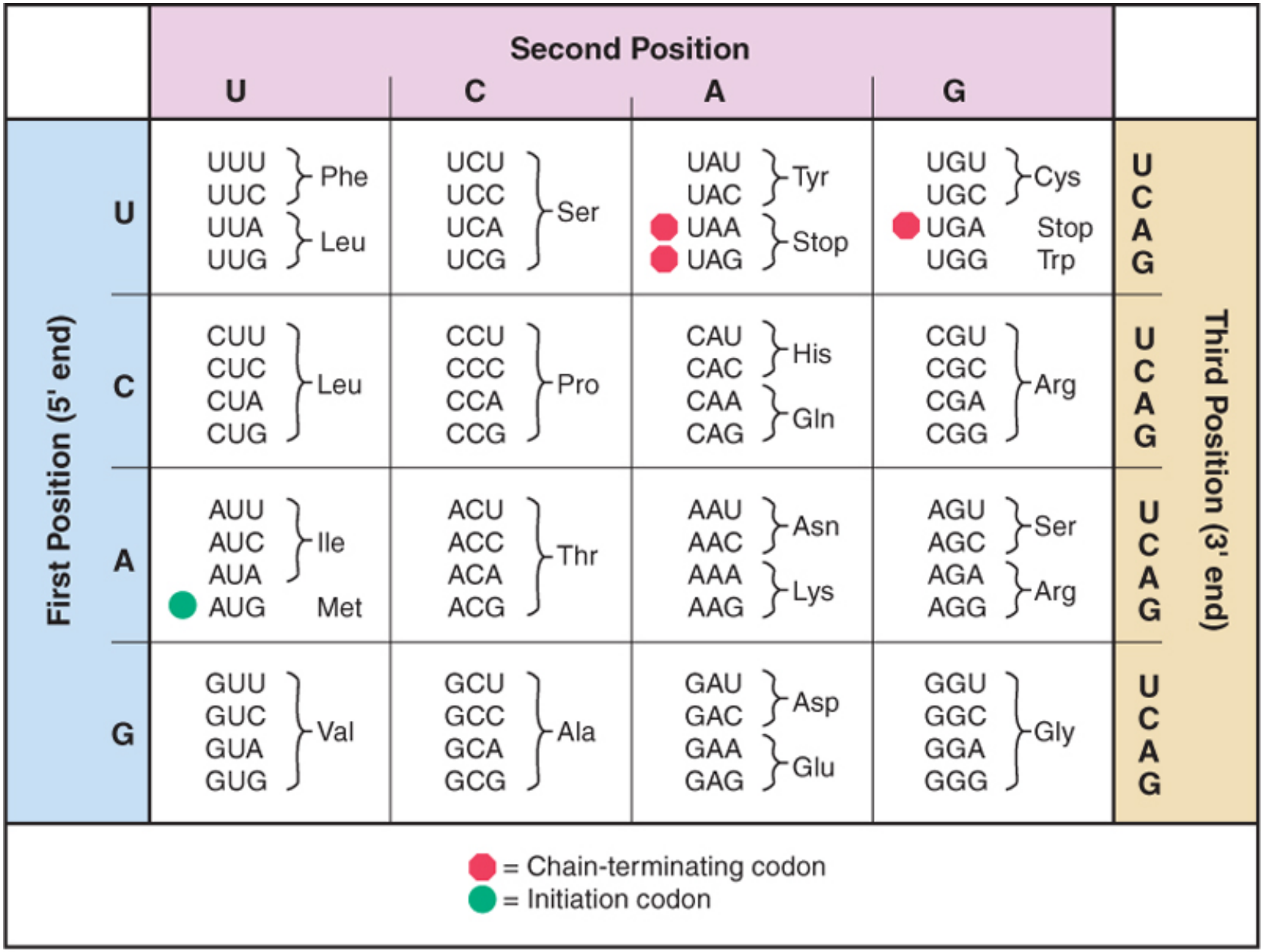
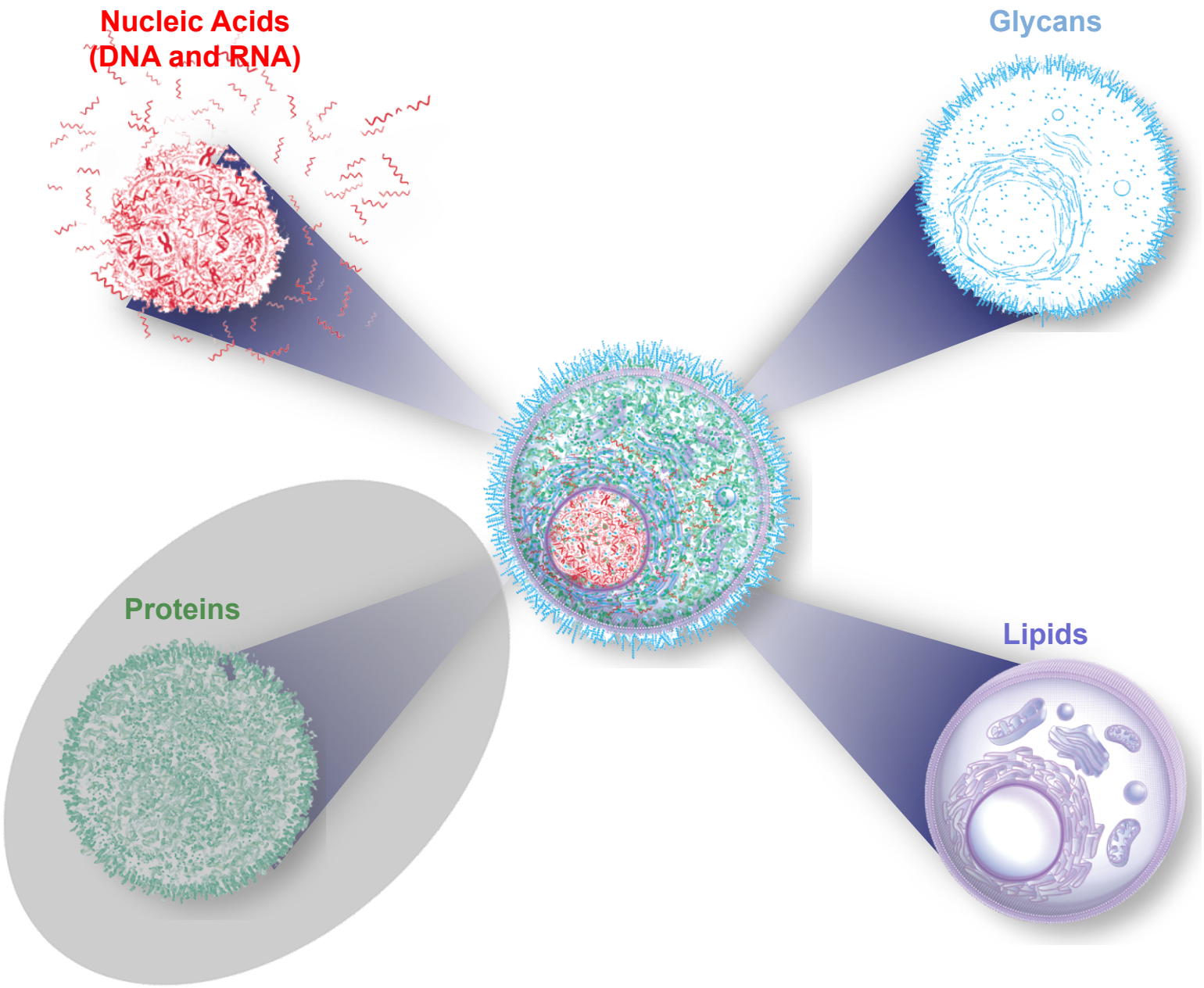


Figure 1-4 Molecular Biology of the Cell 5/e (© Garland Science 2008)

The Genetic Code



Cells are Composed of Four Types of Molecular Components



Proteins are Used to Make Up Many (But Not All) Structures of the Cell

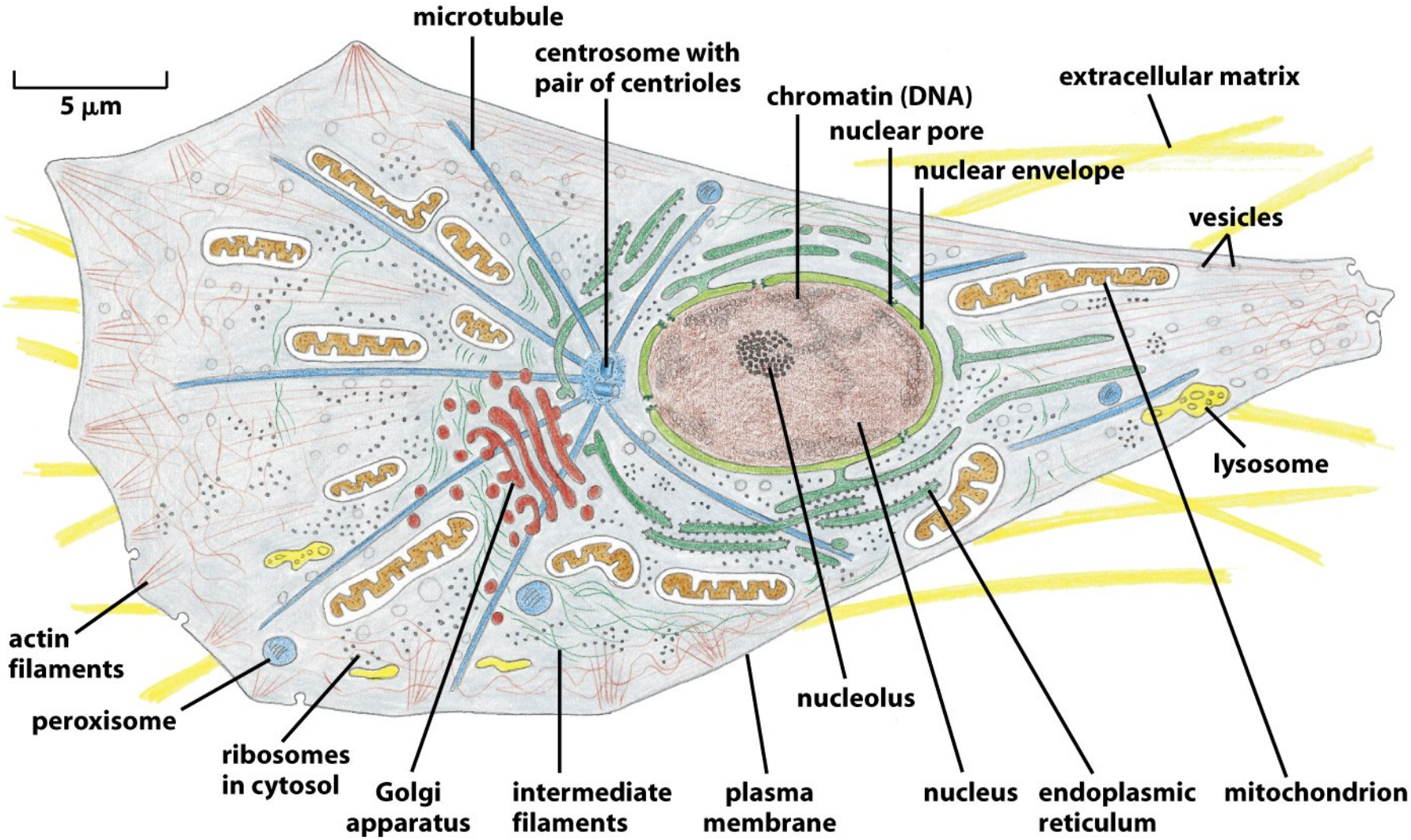
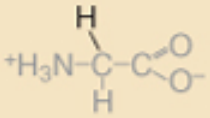


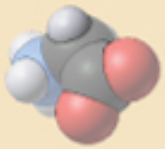
Figure 1-30 Molecular Biology of the Cell 5/e (© Garland Science 2008)

AMINO ACIDS IN PROTEIN SYNTHESIS

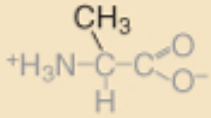
UNCHARGED

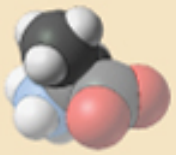
Glycine
Gly
G



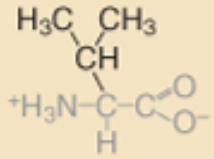


Alanine
Ala
A

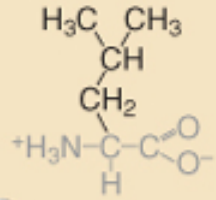


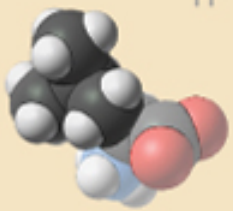


Valine
Val
V

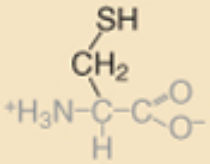


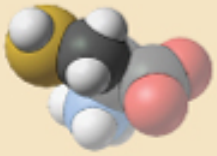
Leucine
Leu
L



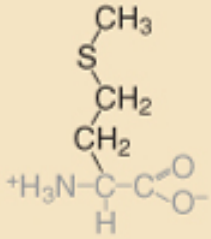


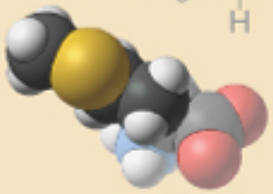
Cysteine
Cys
C



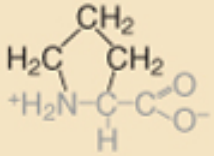


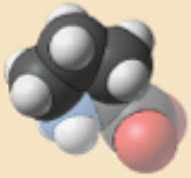
Methionine
Met
M



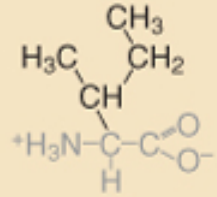


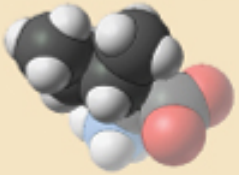
Proline
Pro
P



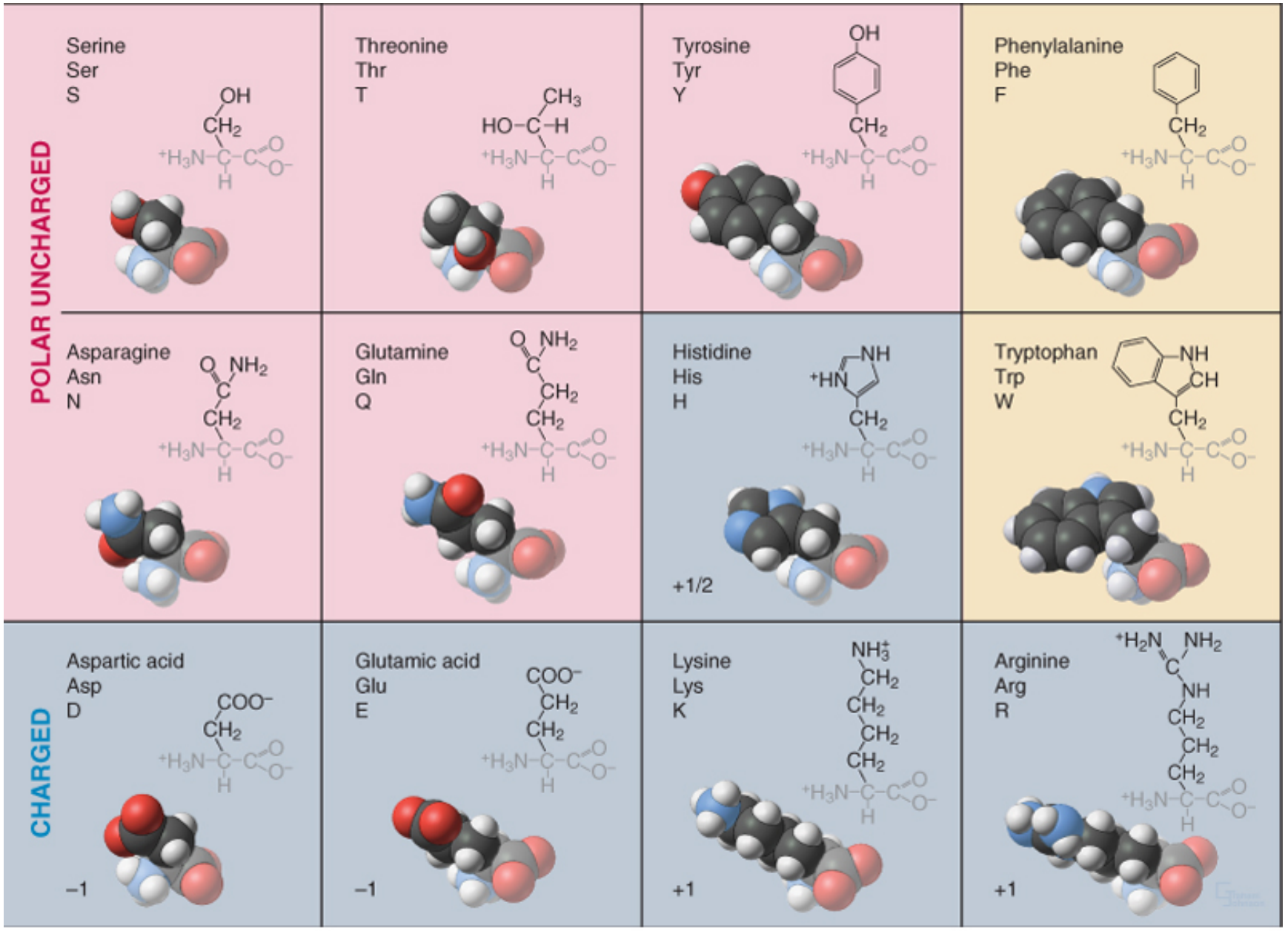


Isoleucine
Ile
I





AMINO ACIDS IN PROTEIN SYNTHESIS



Why are Some Amino Acids Electrochemically Charged in the Cell?

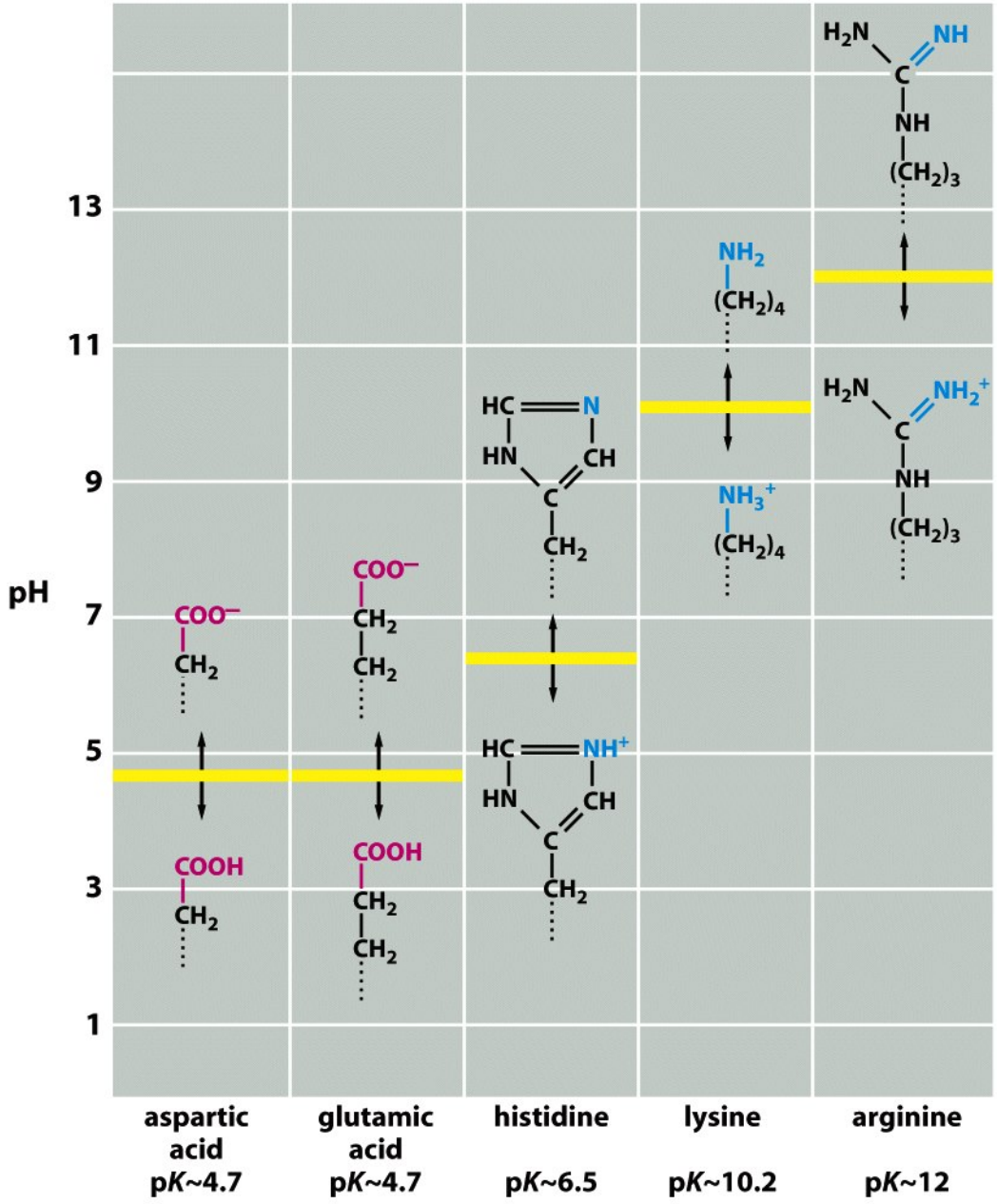
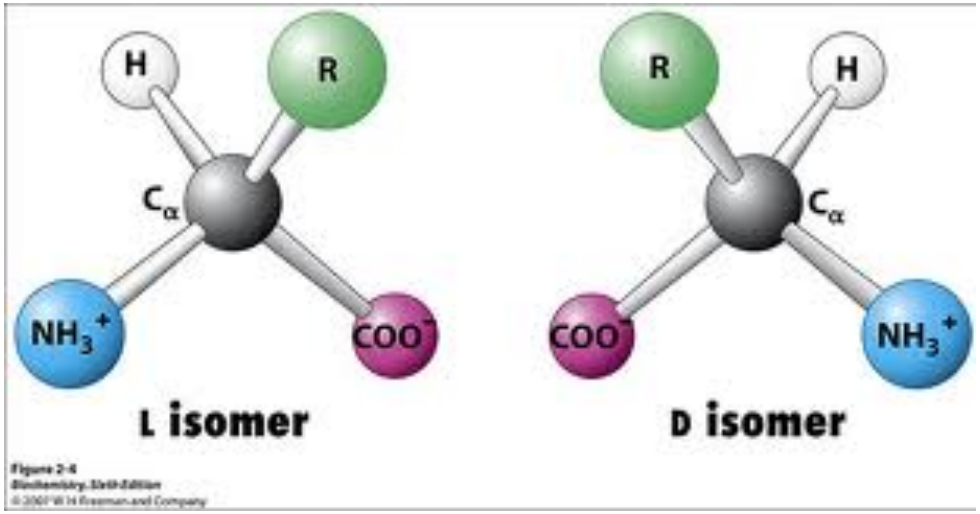


Figure 2-25 *Molecular Biology of the Cell* (© Garland Science 2008)

D versus L amino acids



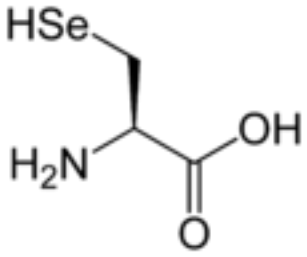
Of the standard amino acids, all but glycine can exist in either of two optical isomers, called L or D amino acids, which are mirror images of each other

While L-amino acids represent all of the amino acids found in proteins during translation in the ribosome, D-amino acids are found in some proteins produced by enzyme posttranslational modifications. D- alanine and D-glutamic acid are structural components of certain bacterial walls.

Amino Acids are Chiral

UNUSUAL AMINO ACIDS IN PROTEIN SYNTHESIS

Selenocysteine (Se-Cys)



Encoded in mRNA by the UAG codon, which in most organisms is the 'amber' stop codon.

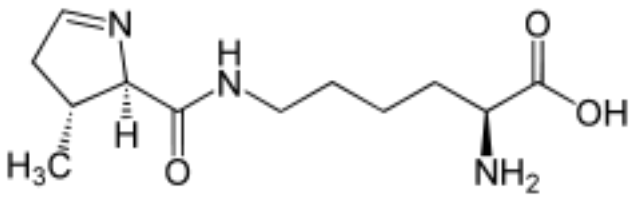
Considered the 21st protogenic amino acid

The UGA codon is made to encode selenocysteine by the presence of a SECIS element (SElenoCysteine Insertion Sequence) in the mRNA. The SECIS element is defined by characteristic nucleotide sequences and secondary structure base-pairing patterns.

Selenocysteine is present in several enzymes in eukaryotes.

UNUSUAL AMINO ACIDS IN PROTEIN SYNTHESIS

Pyrrolysine



Encoded in mRNA by the UAG codon, which in most organisms is the 'amber' stop codon.

Considered the 22nd protogenic amino acid

Used by some methanogenic archaea and one known bacterium in enzymes that are part of their methane-producing metabolism.

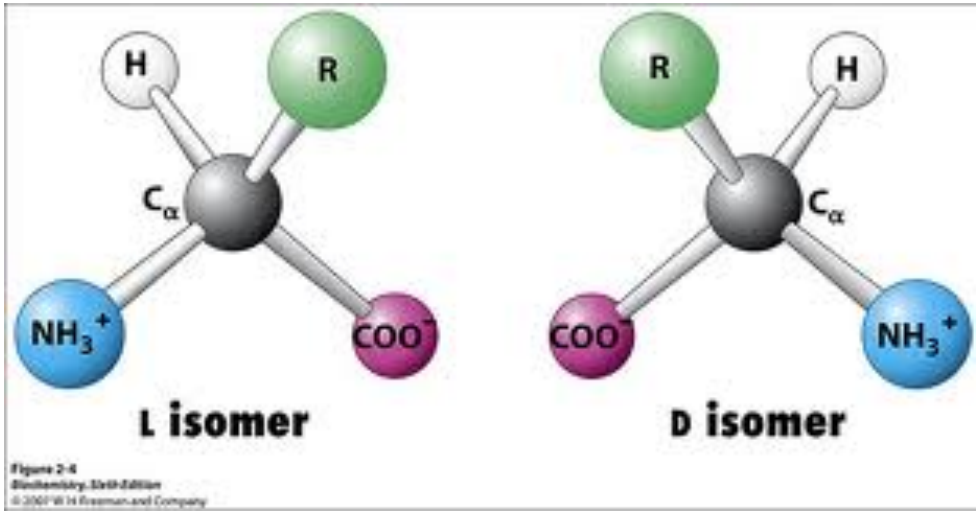
Essential and Non-Essential Amino Acids

Essential	Nonessential
Isoleucine	Alanine
Leucine	Arginine*
Lysine	Aspartate
Methionine	Cysteine*
Phenylalanine	Glutamate
Threonine	Glutamine*
Tryptophan	Glycine*
Valine	Proline*
Histidine	Serine
	Tyrosine*
Asparagine*	
Selenocysteine**	Pyrrolysine**

*essential in some cases

**not known

D versus L amino acids



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While L-amino acids represent all of the amino acids found in proteins during translation in the ribosome, D-amino acids are found in some proteins produced by enzyme posttranslational modifications. D- alanine and D-glutamic acid are structural components of certain bacterial walls.

Amino Acids are Chiral

Proteins are Amino Acids Linked Together by the Peptide Bond

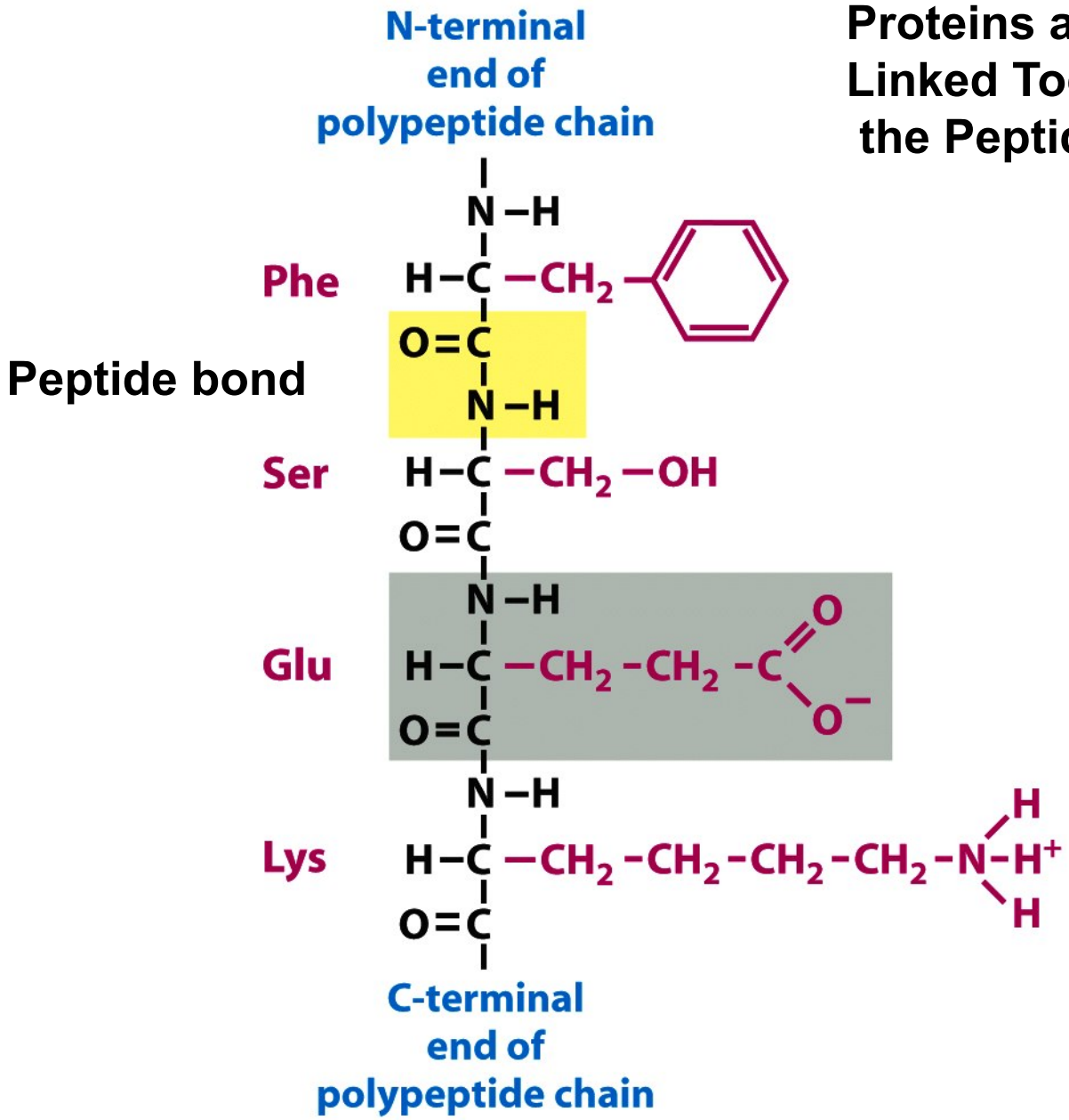


Figure 2-24 *Molecular Biology of the Cell* (© Garland Science 2008)

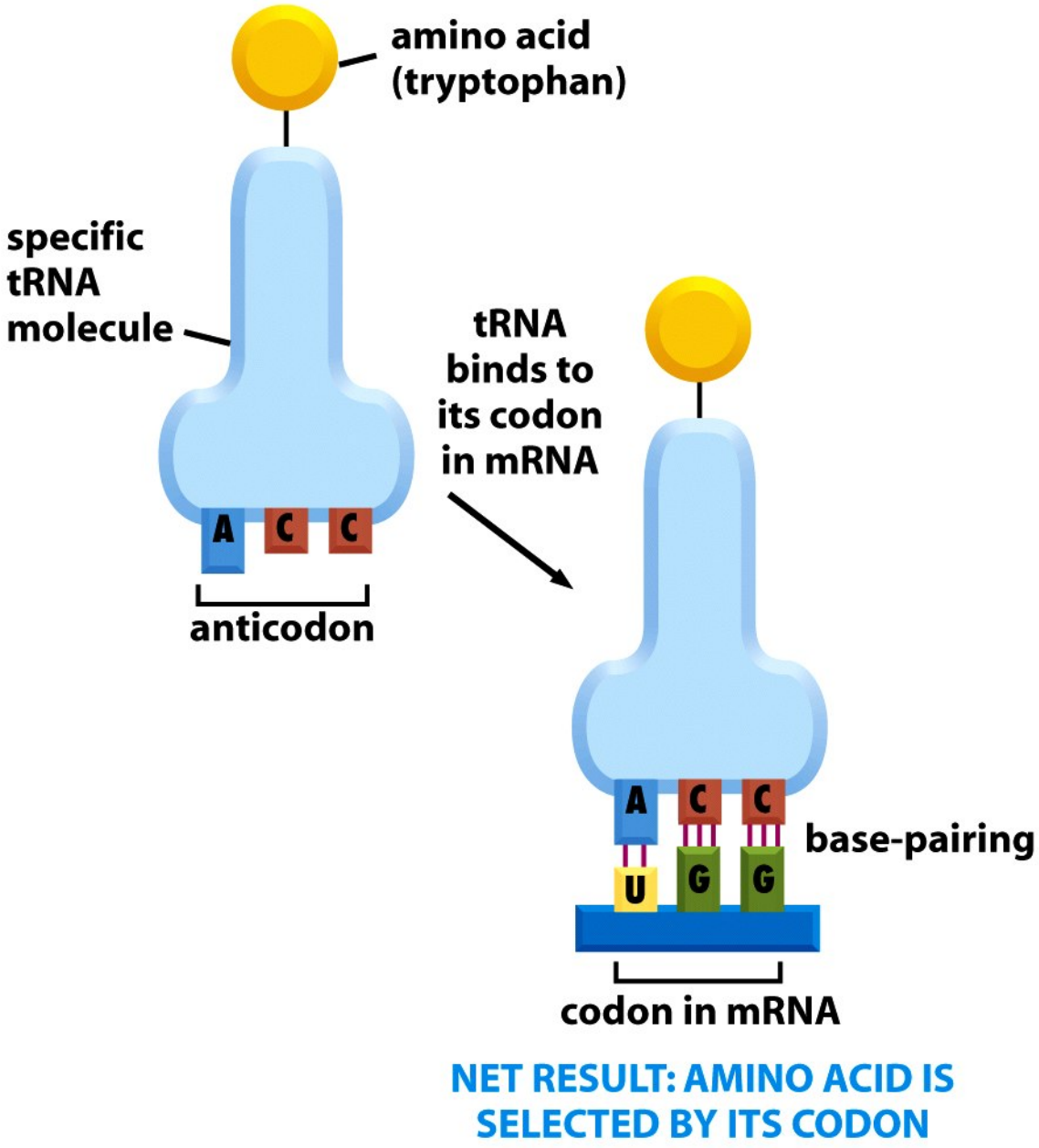


Figure 1-9a Molecular Biology of the Cell 5/e (© Garland Science 2008)

Charging the tRNA with an Amino Acid

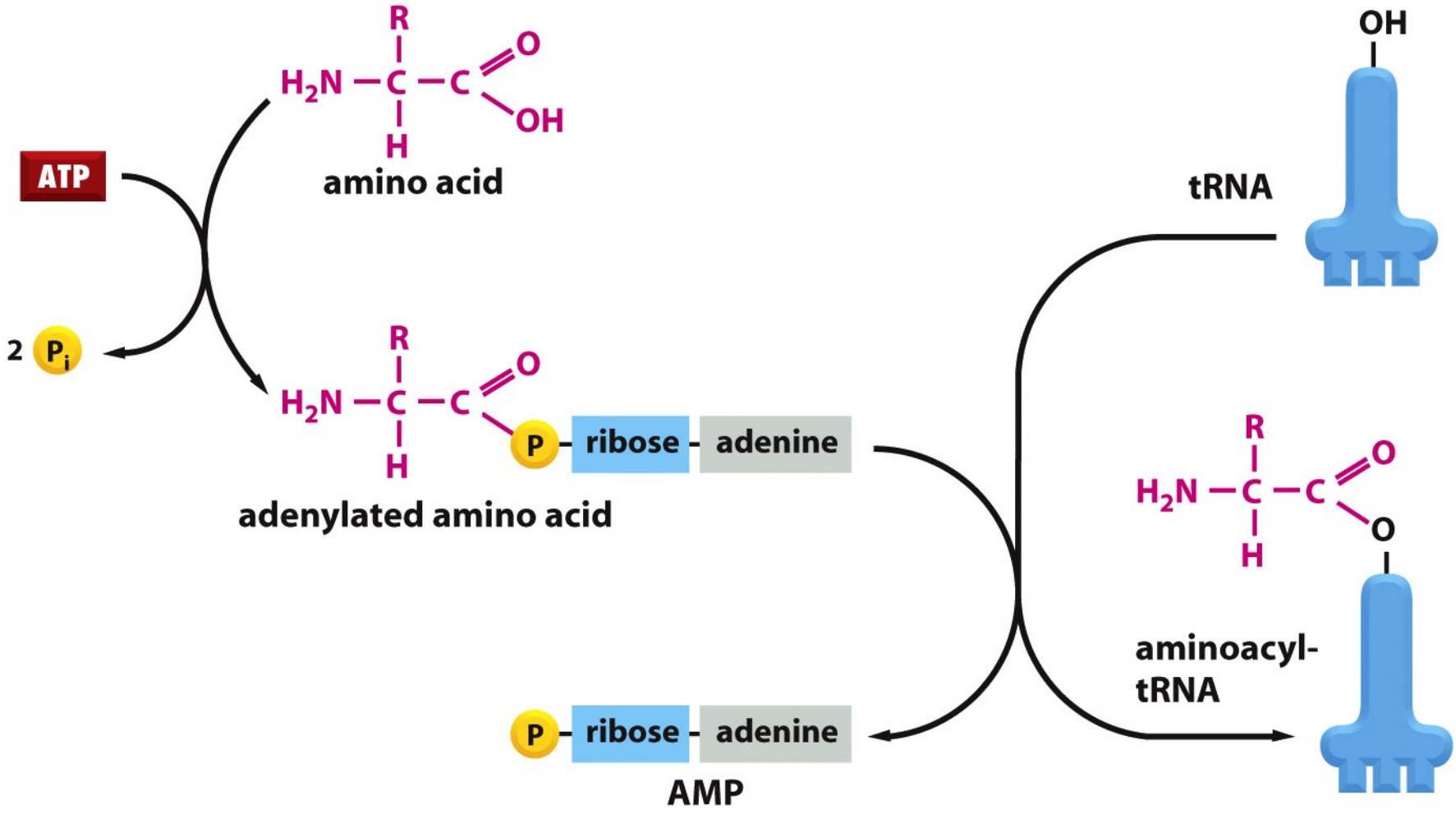
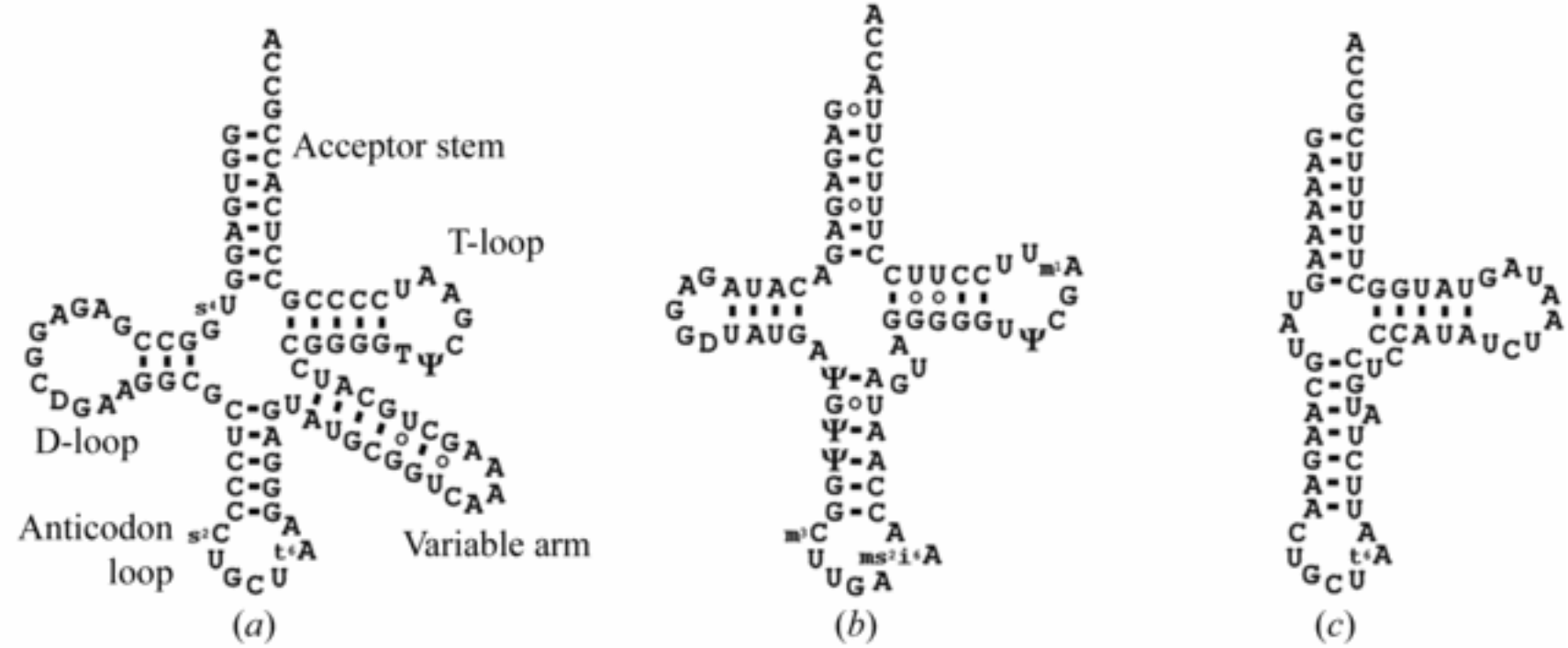


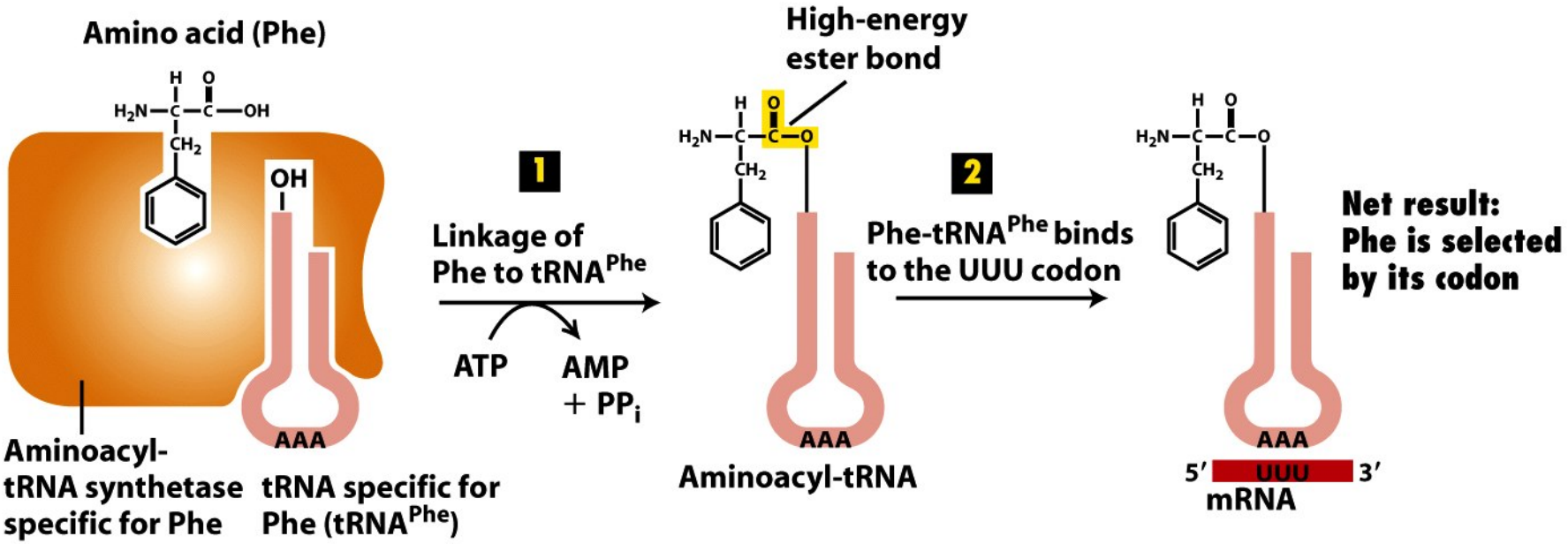
Figure 6-56 Molecular Biology of the Cell 5/e (© Garland Science 2008)

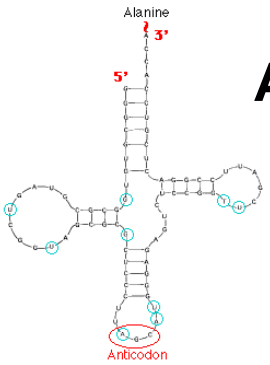
tRNA Structure Contributes to tRNA Function



Serine tRNAs

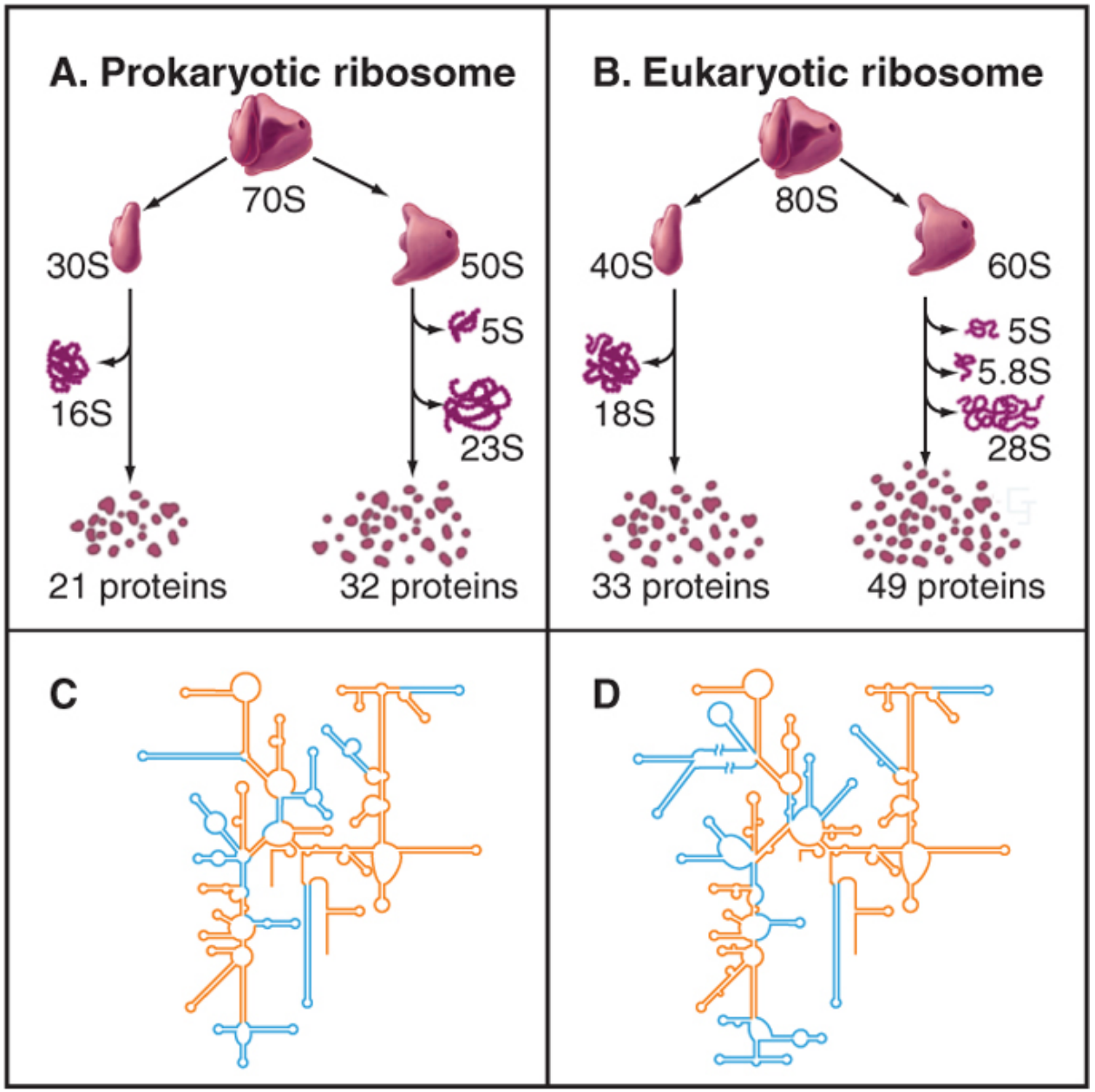
Determining tRNA Identity and Function





Alanine t-RNA structure

The Composition of Ribosomes



16S RNA

18S RNA

Translation of the mRNA into Protein

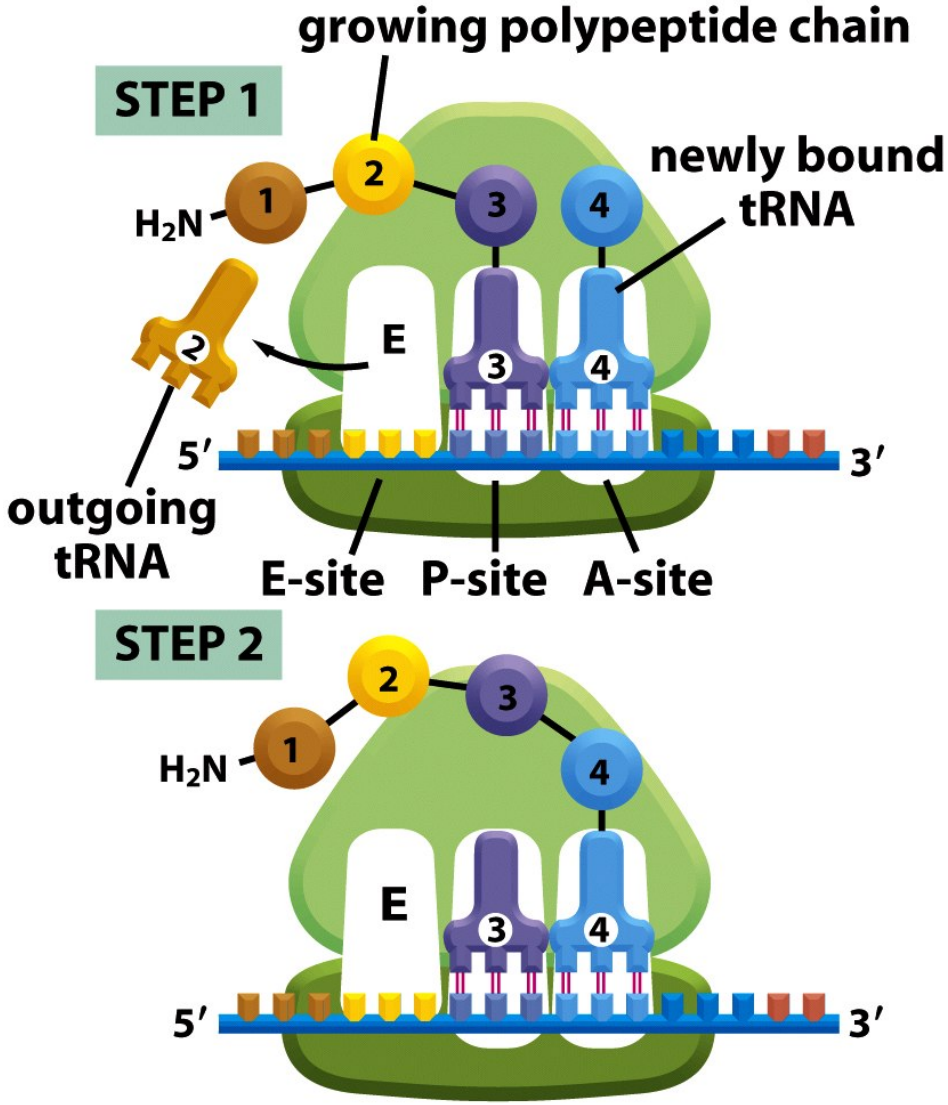


Figure 6-66 part 1 of 7 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Translation of the mRNA into Protein

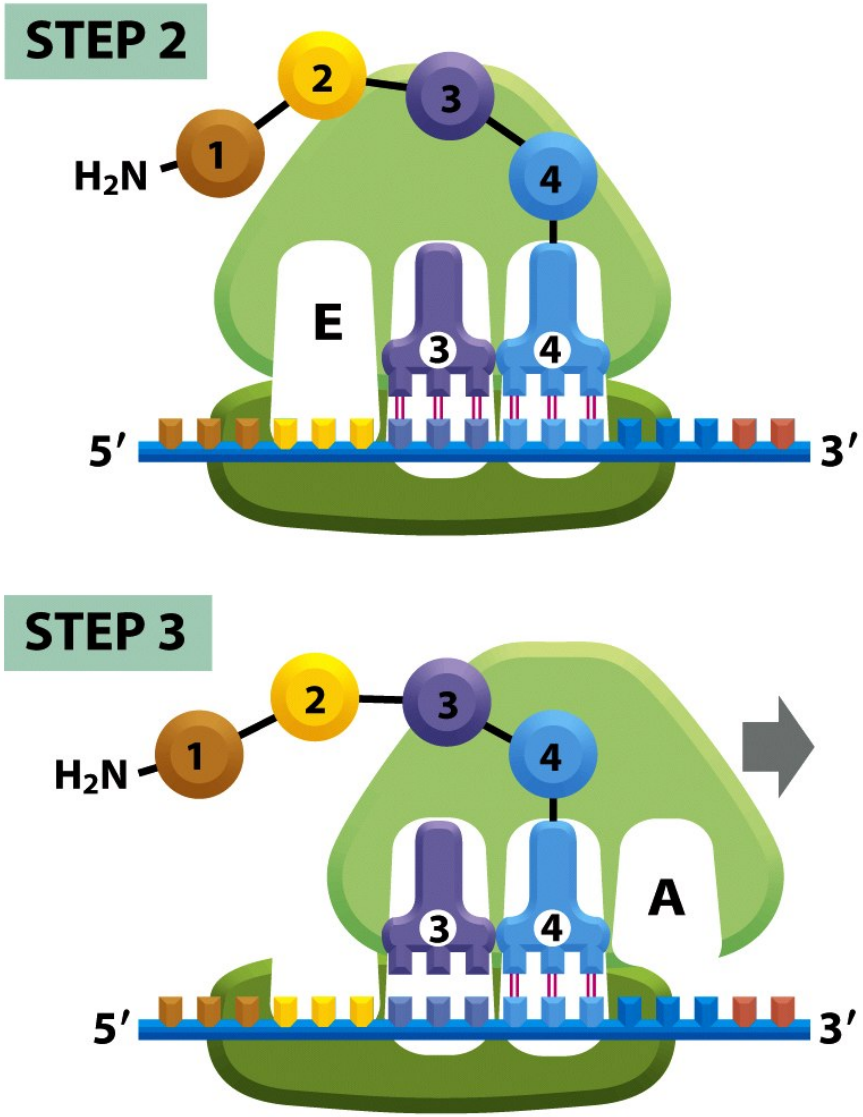


Figure 6-66 part 2 of 7 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Translation of the mRNA into Protein

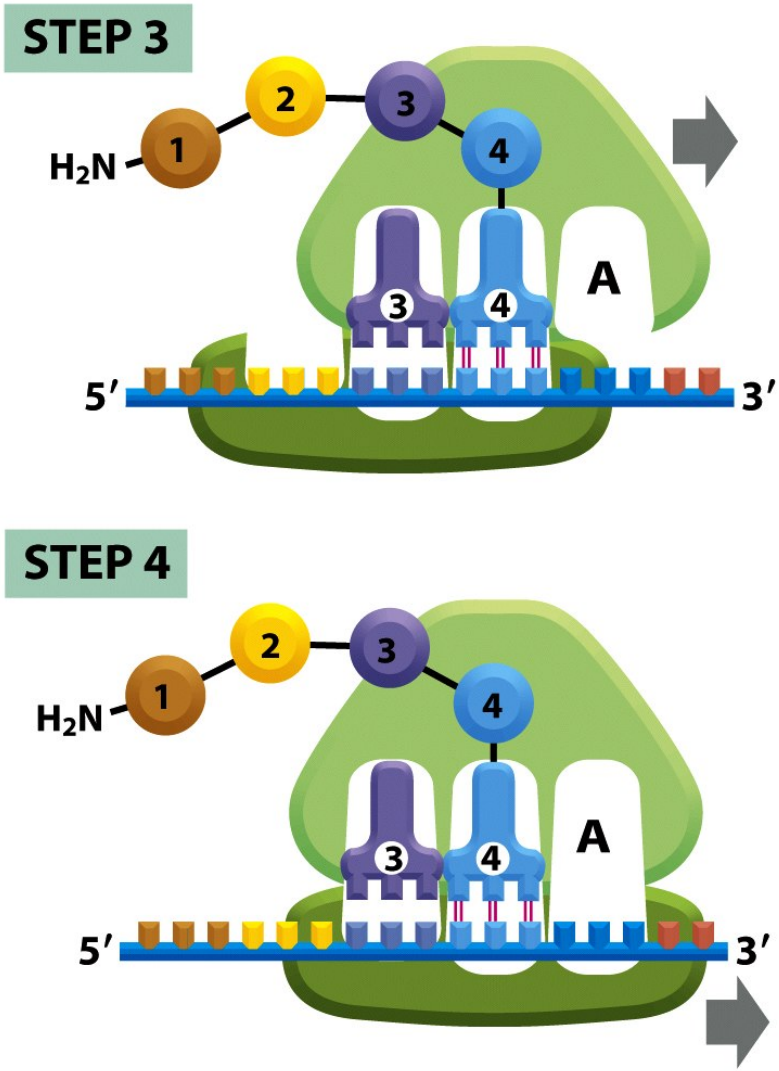


Figure 6-66 part 3 of 7 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Translation of the mRNA into Protein

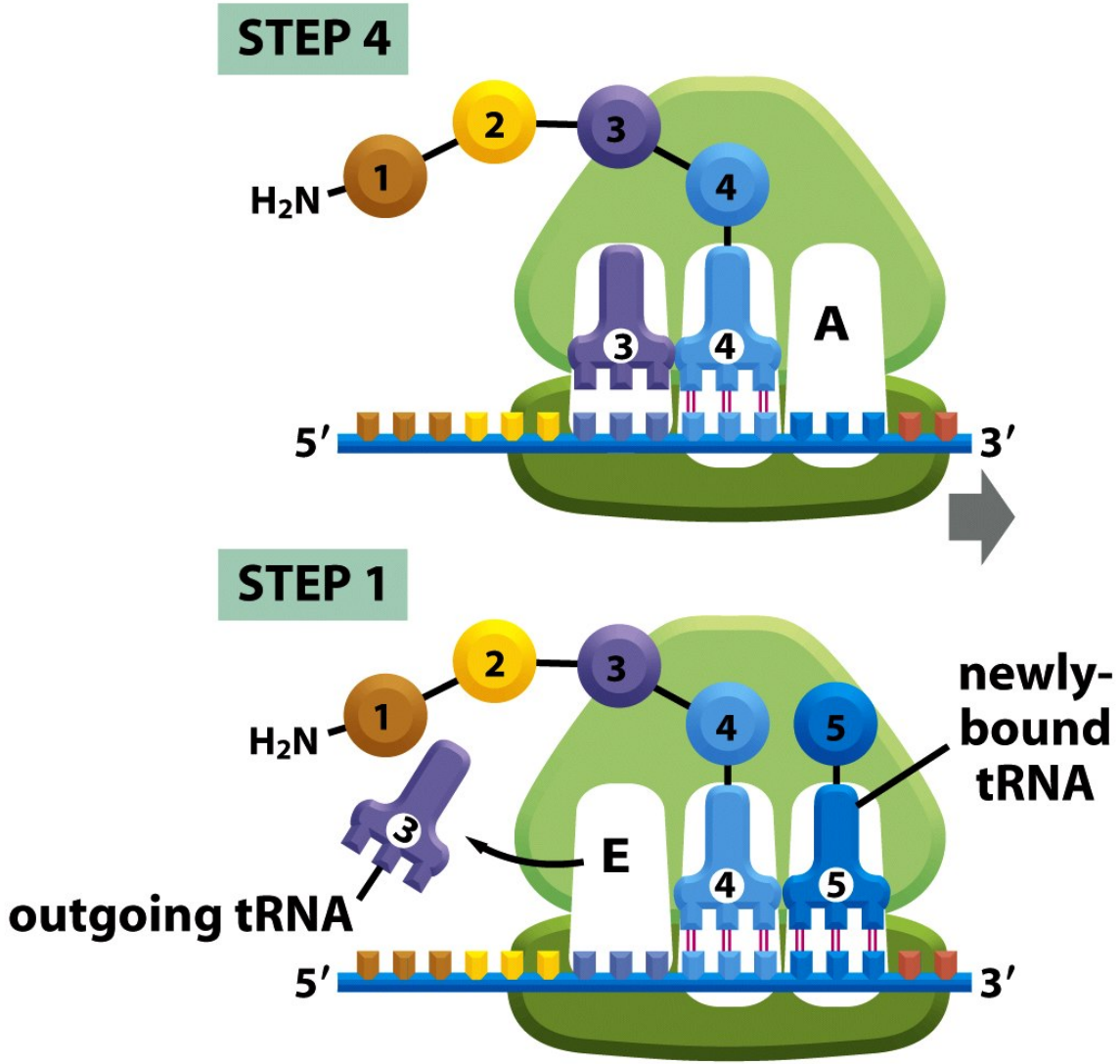


Figure 6-66 part 4 of 7 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Translation of the mRNA into Protein

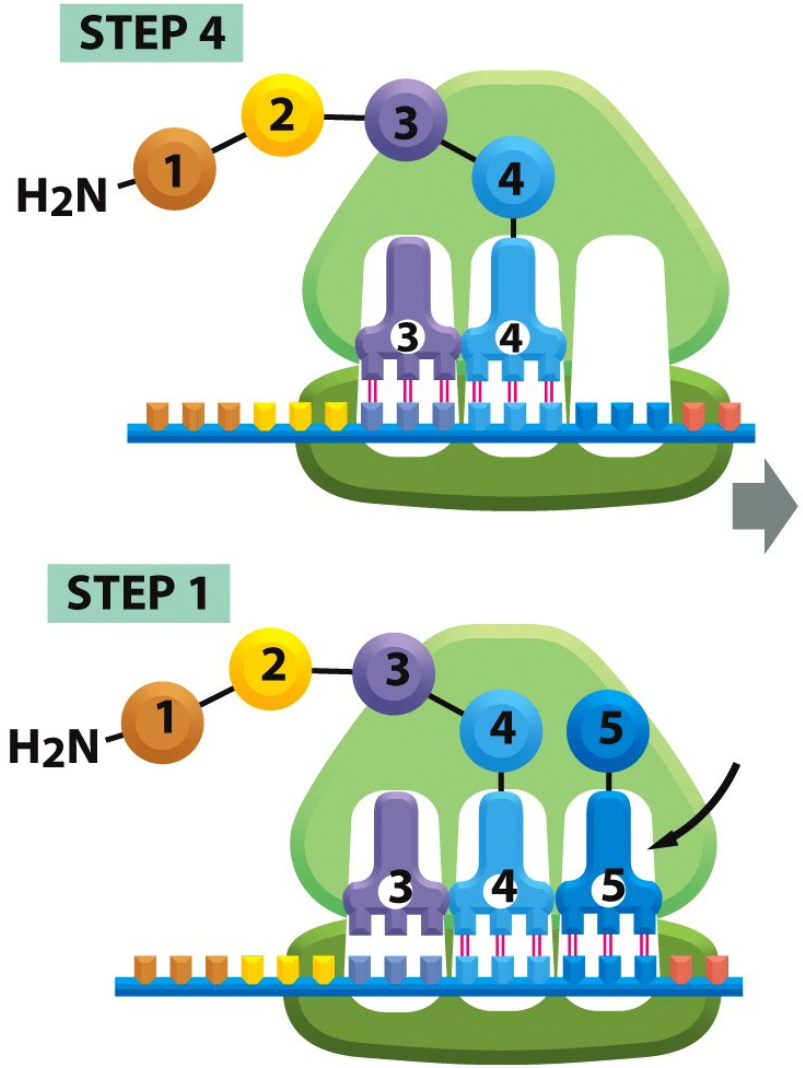


Figure 6-66 part 5 of 7 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Translation of the mRNA into Protein

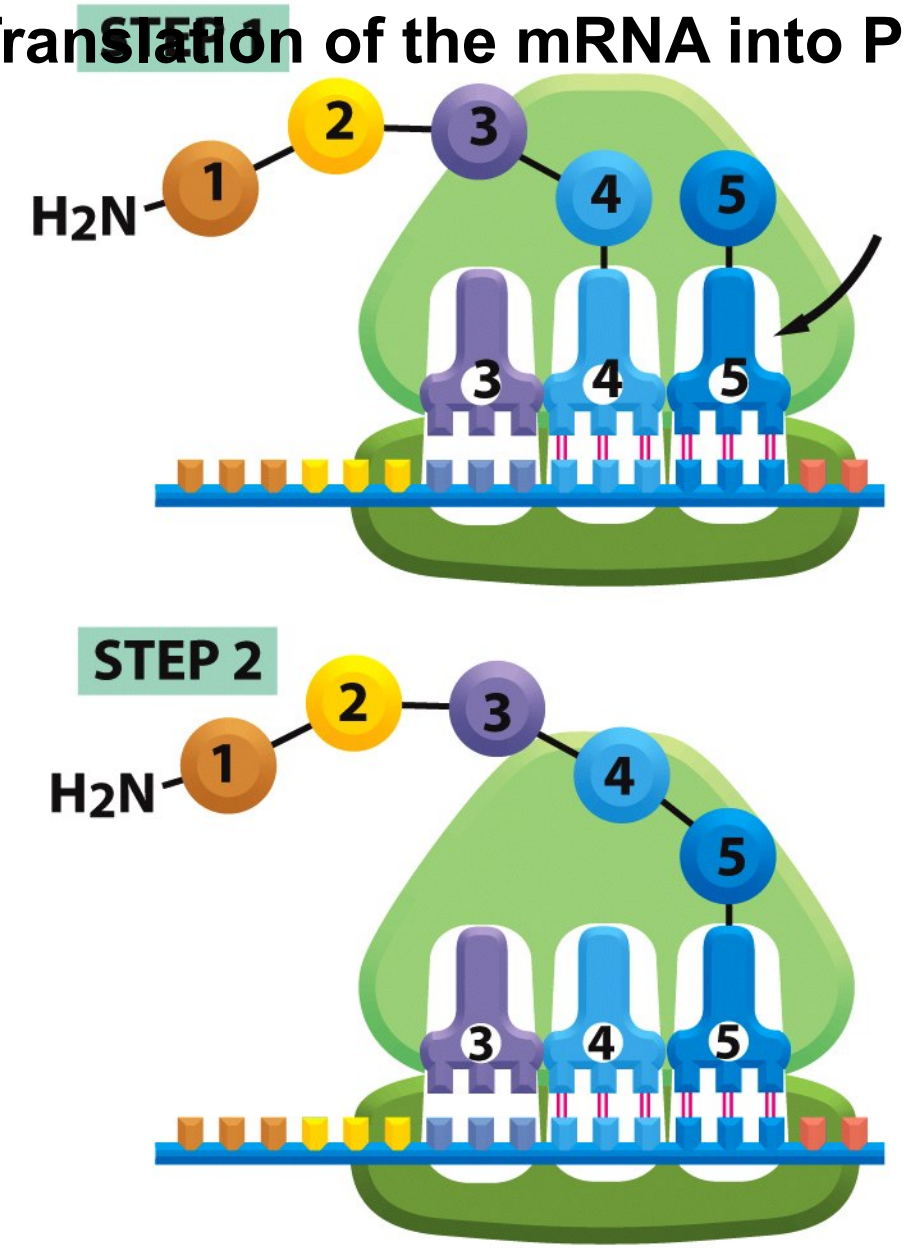


Figure 6-66 part 6 of 7 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Translation of the mRNA into Protein

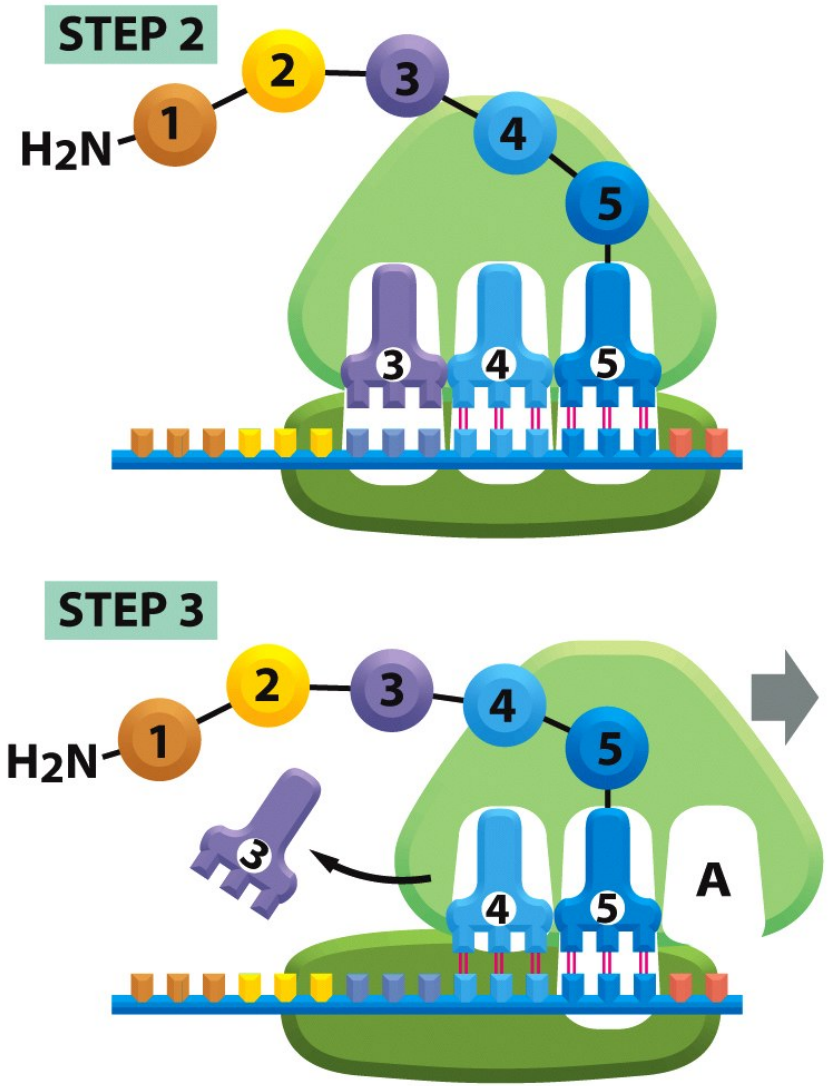
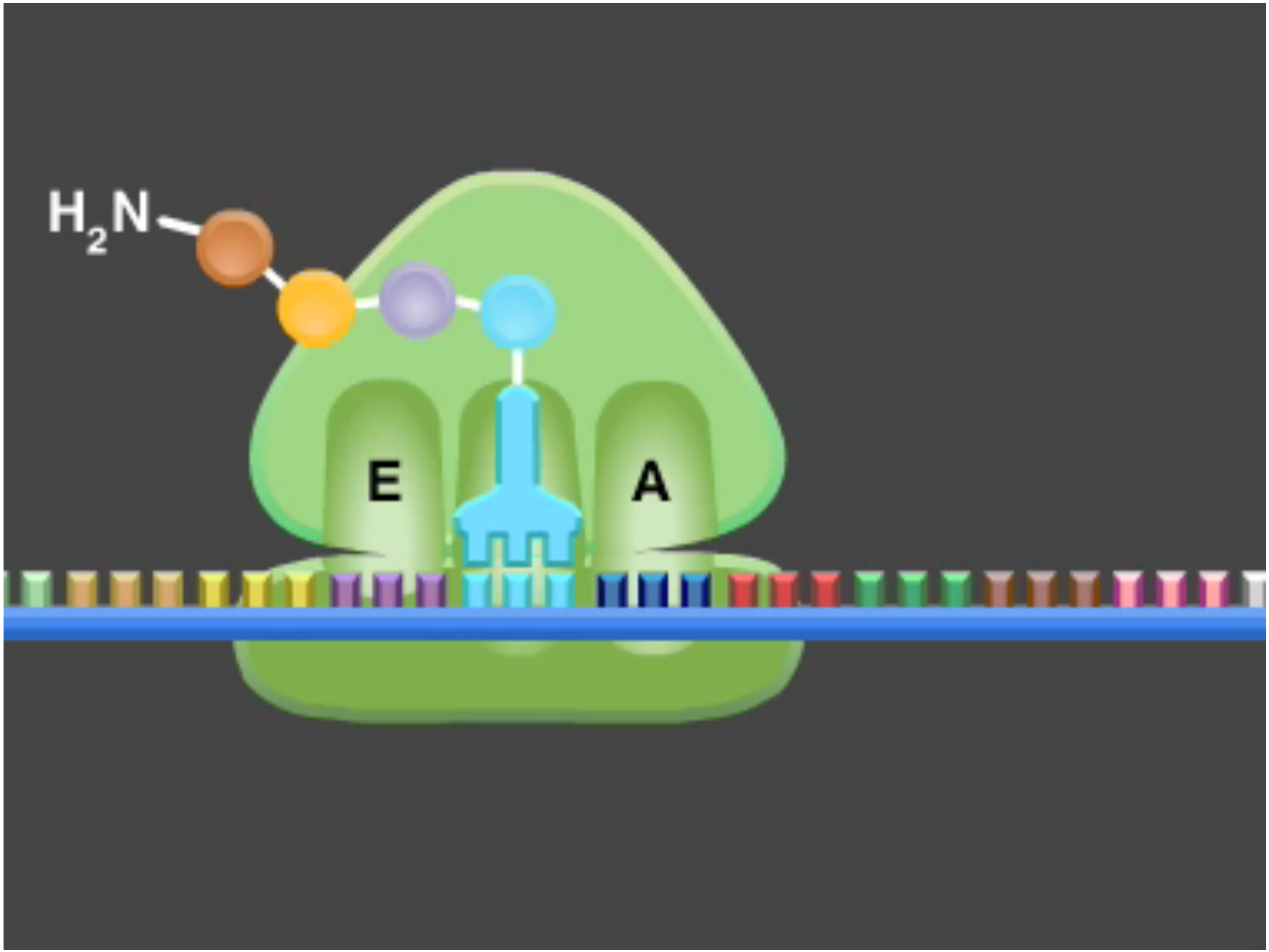
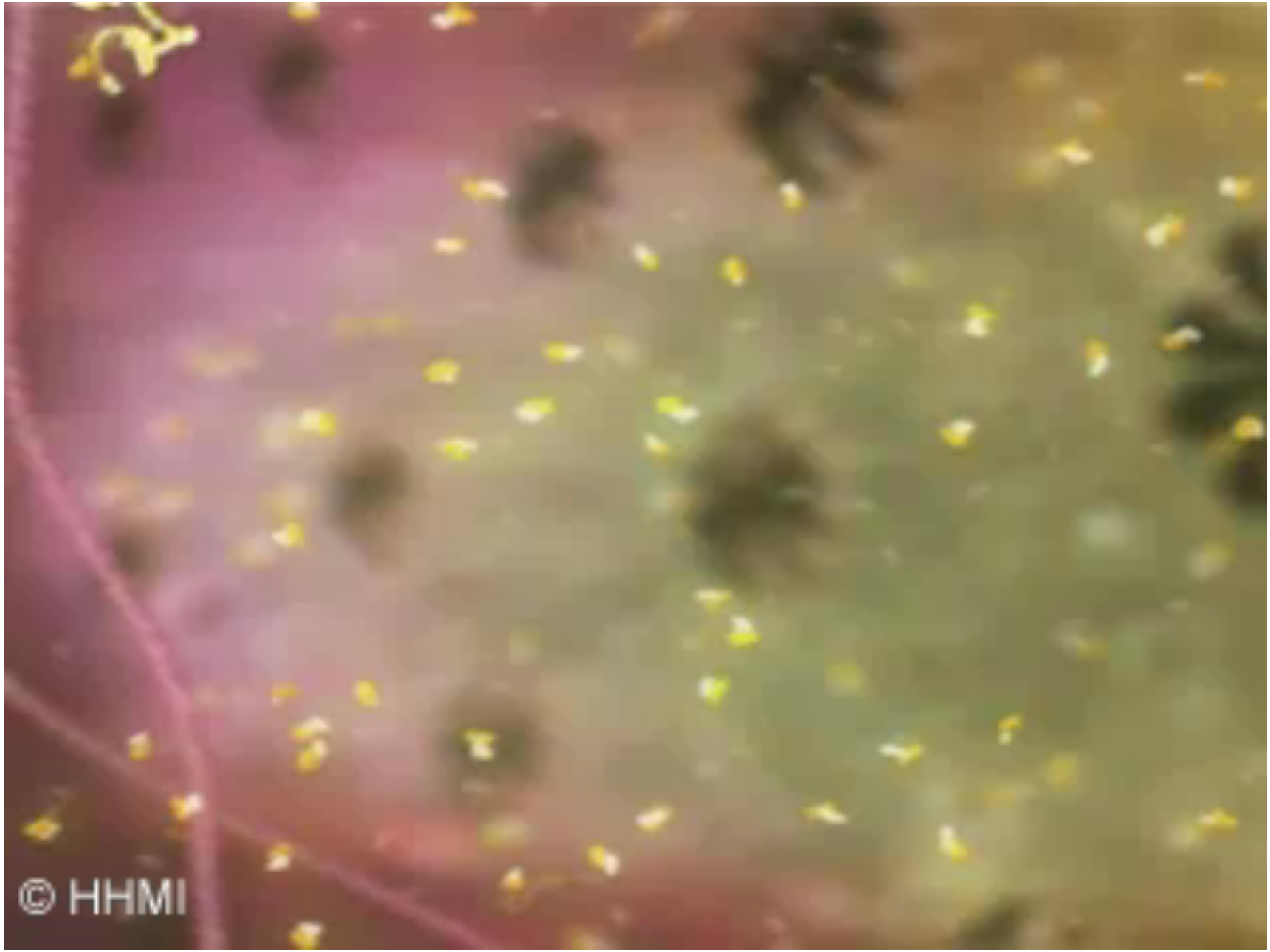


Figure 6-66 part 7 of 7 Molecular Biology of the Cell 5/e (© Garland Science 2008)

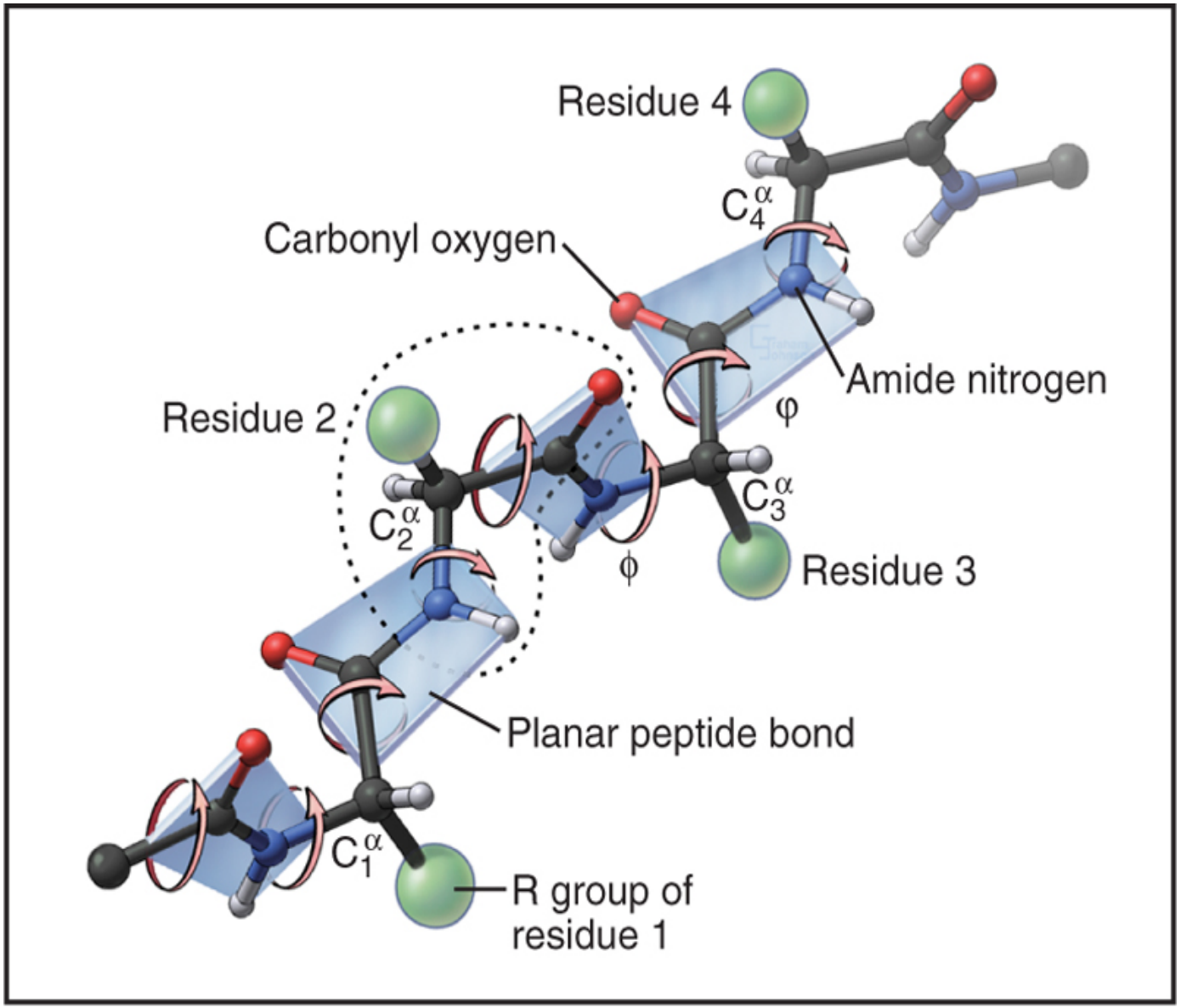
Model of Stepwise Process of Translation (Movie)



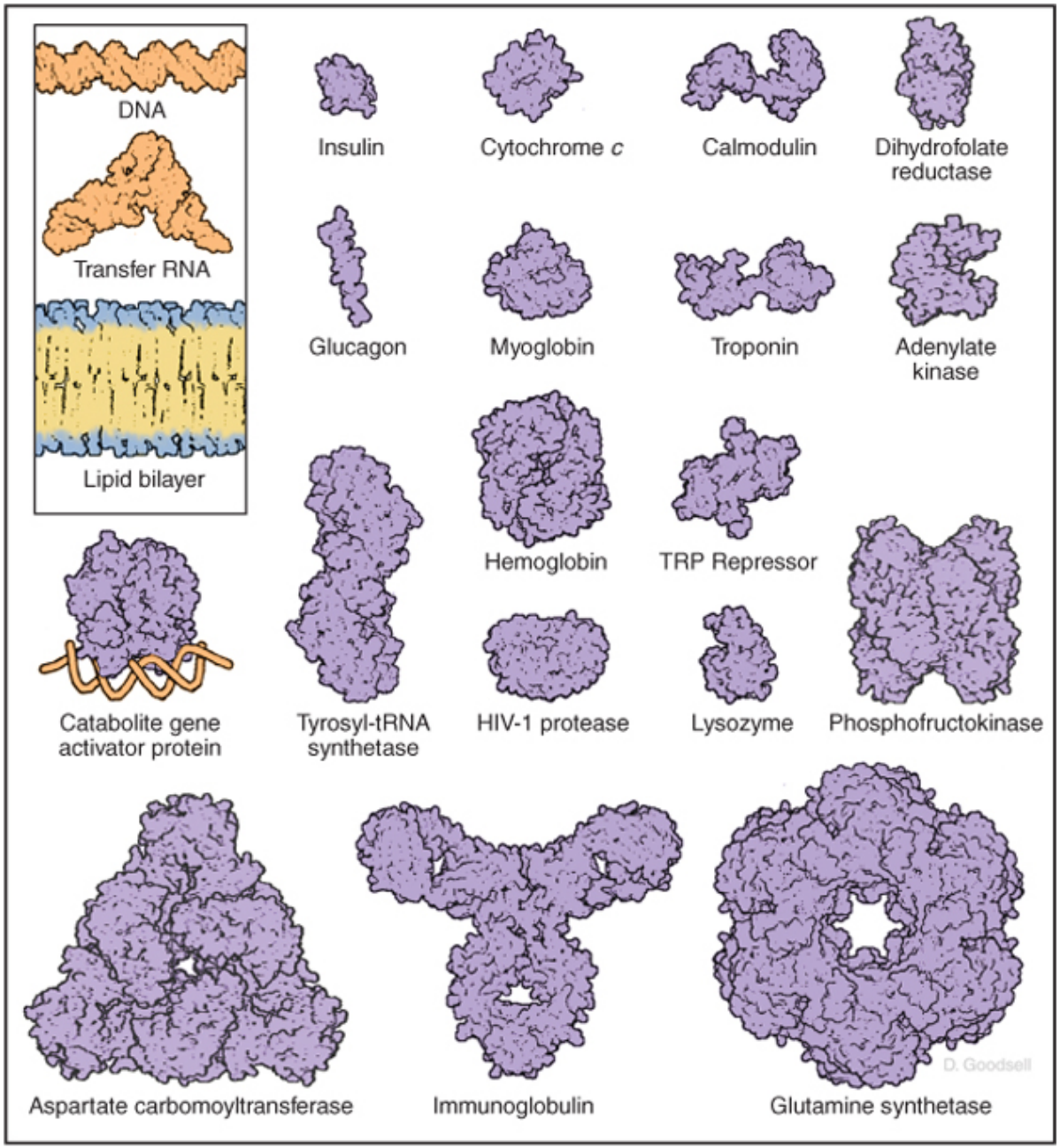
Translation (Movie)



Geometry and Flexibility of Amino Acids in Proteins



Proteins Exist as a Diverse Repertoire of Biological Structures



Protein Domains

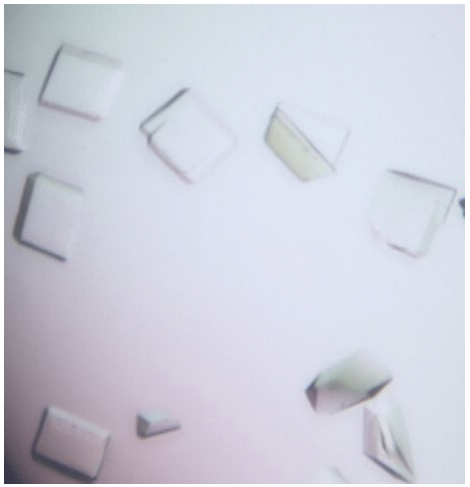
A protein domain is a structurally independent unit that has a characteristic of a small globular protein. Thus, a domain is often stable when present alone

A protein domain often has a specific function (e.g. DNA-binding domain, Ca2+ binding domain, etc)

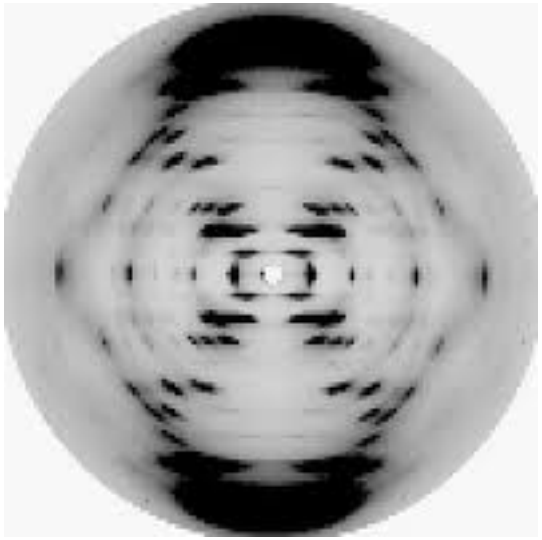
A protein domain usually consist of 100 to 200 amino acid residues

A protein may have more than one domain

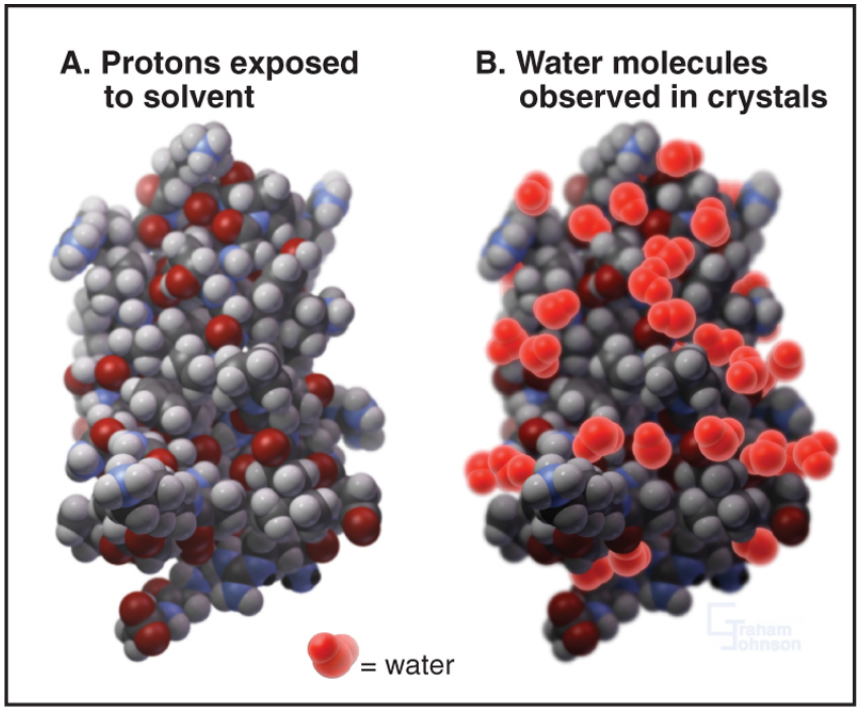
X-Ray Crystallography Has Provided the Most Information on Biological Molecular Structure



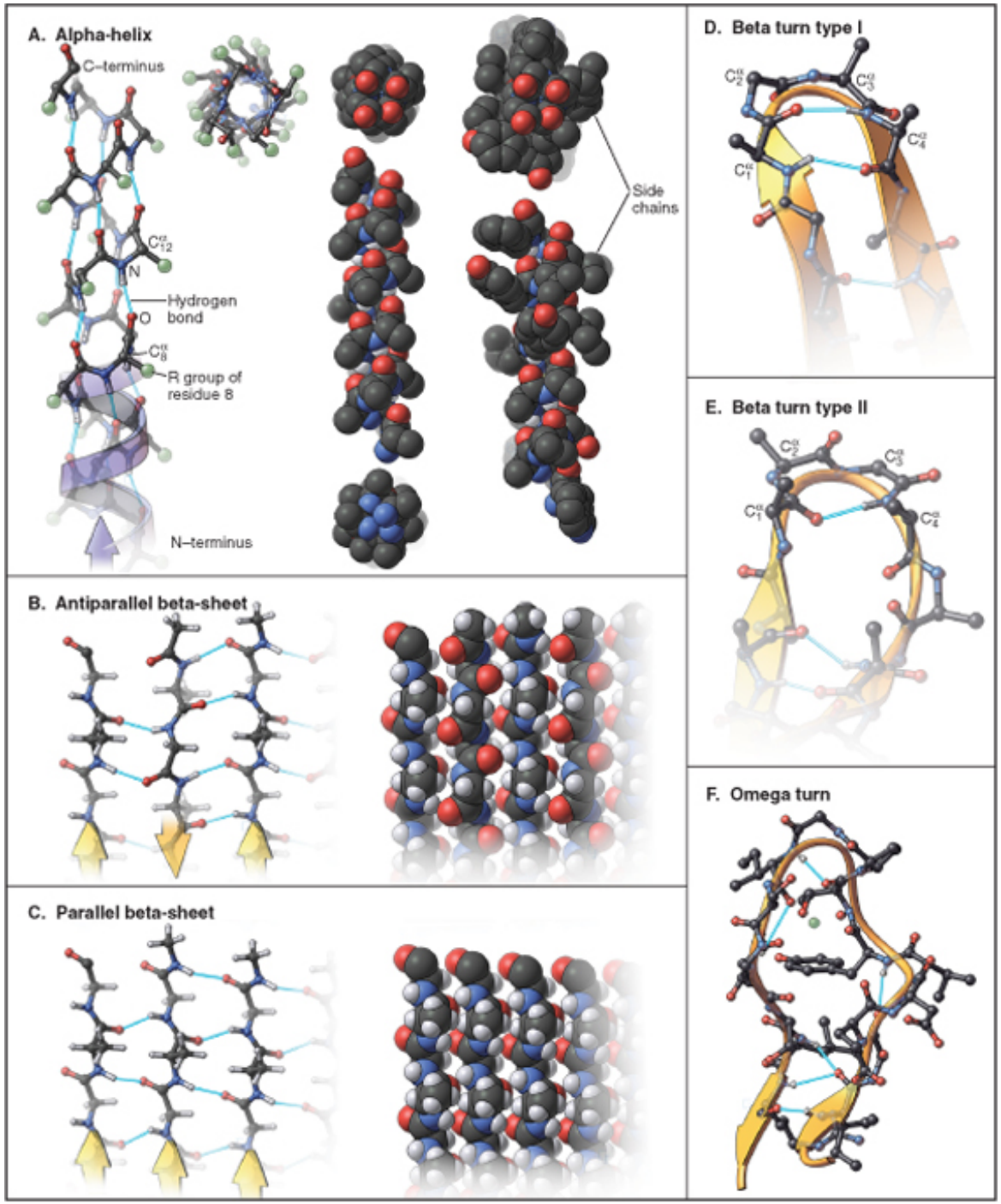
Protein crystals



Diffraction pattern



Protein structures in angstroms



Types of Protein Structures and Folds

What factors cause this?

Proteins Fold into a Conformation

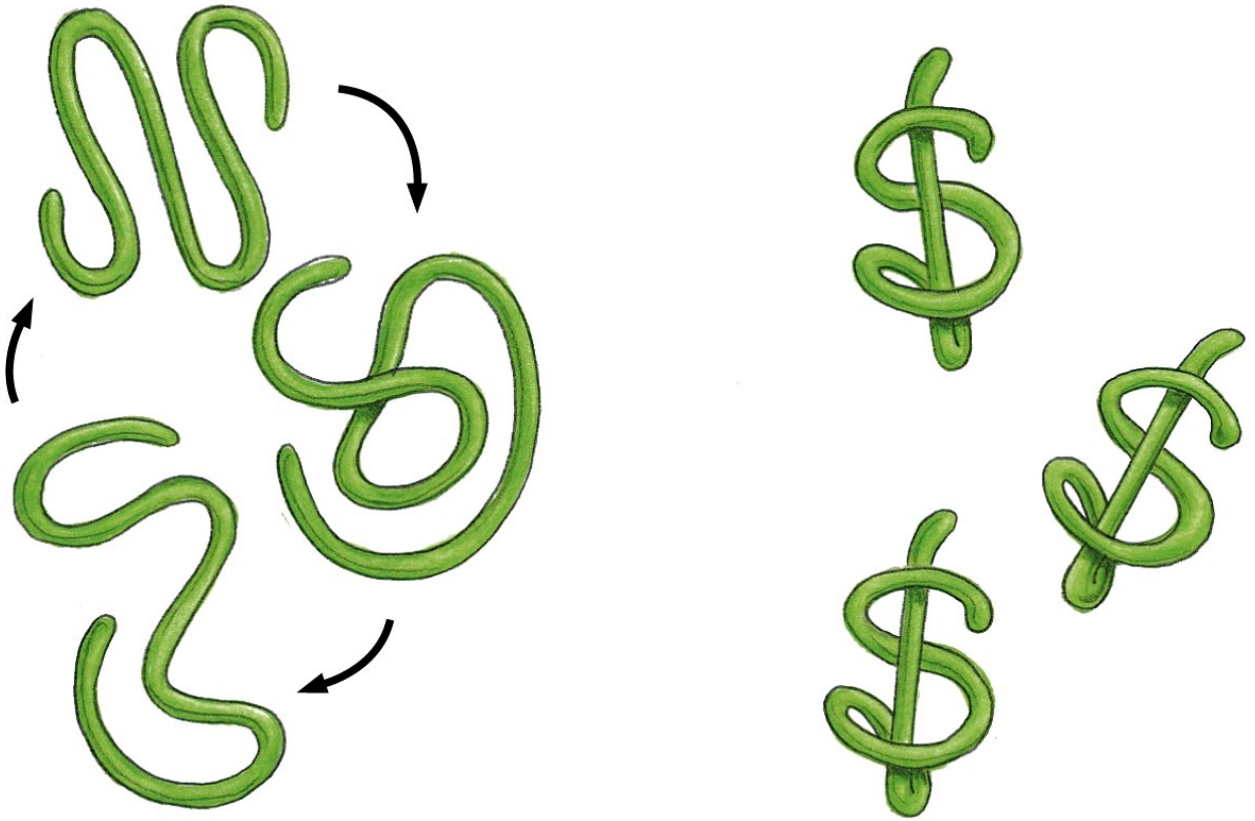


Figure 2-31 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Proteins can be Enzymes

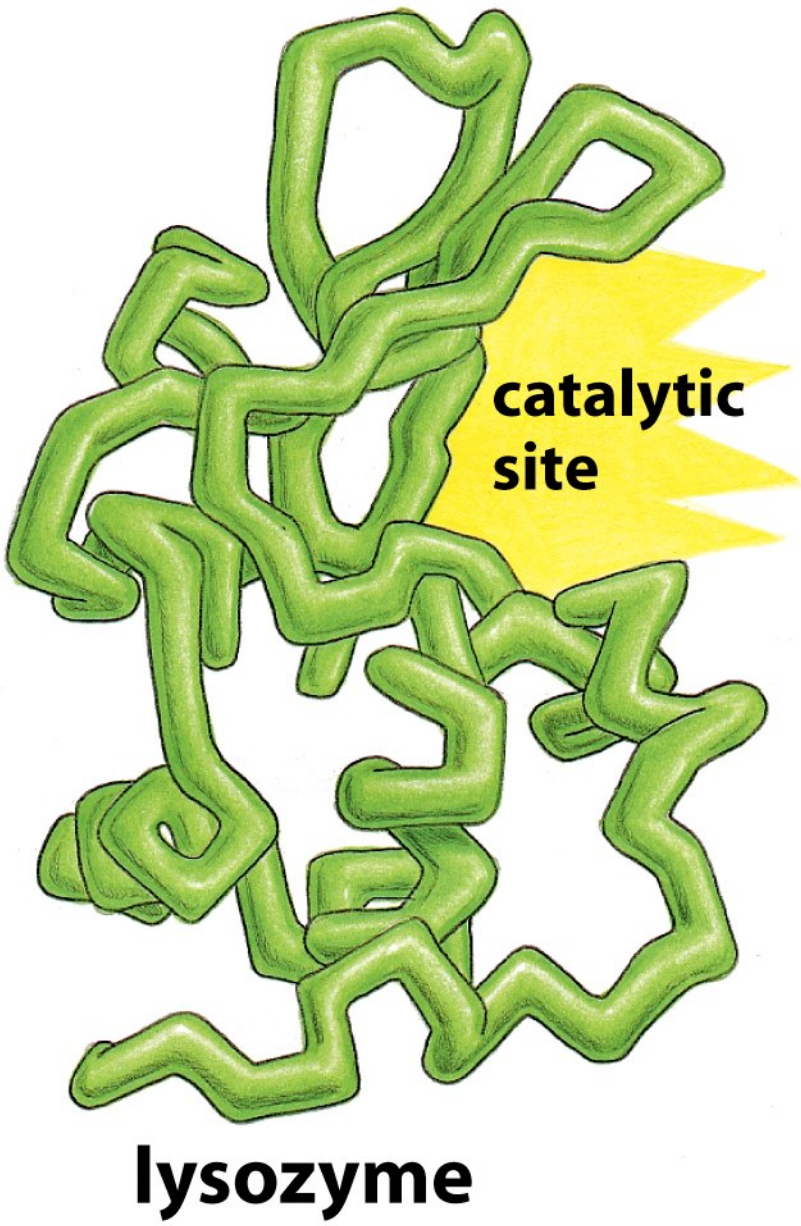


Figure 1-7a Molecular Biology of the Cell 5/e (© Garland Science 2008)

Enzymes Catalyze Reactions

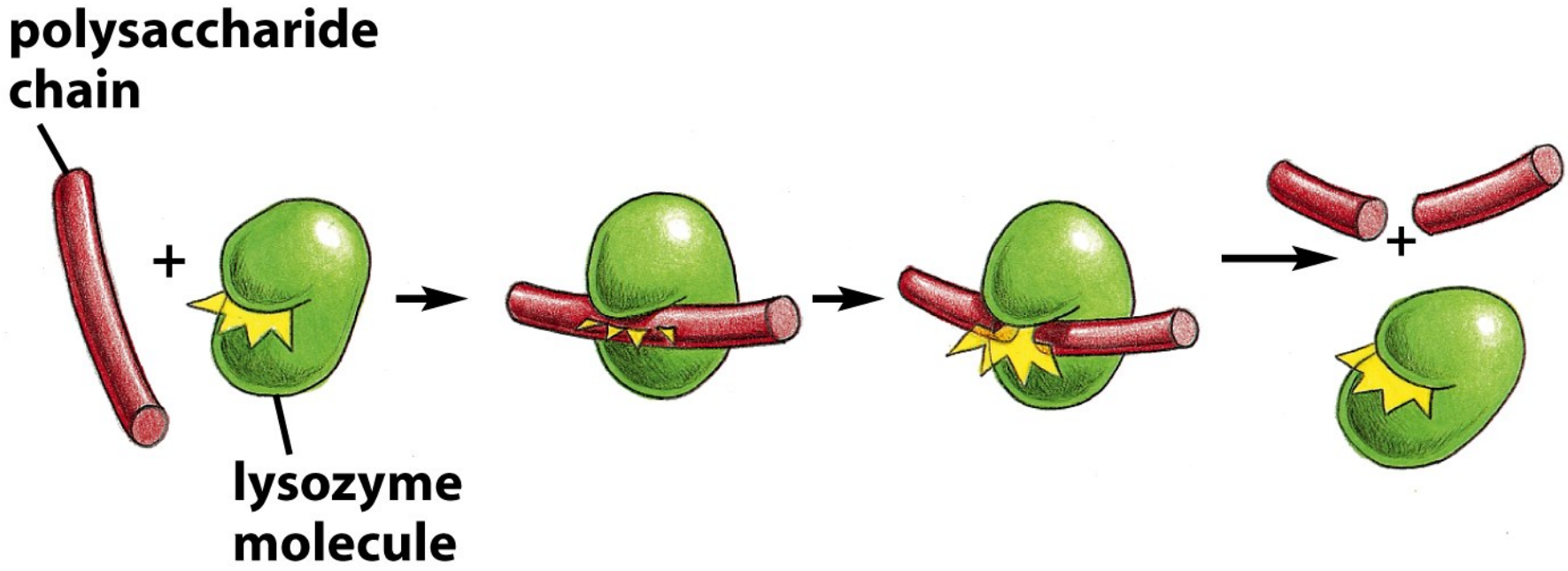


Figure 1-7b Molecular Biology of the Cell 5/e (© Garland Science 2008)

Proteins also Regulate Gene Expression

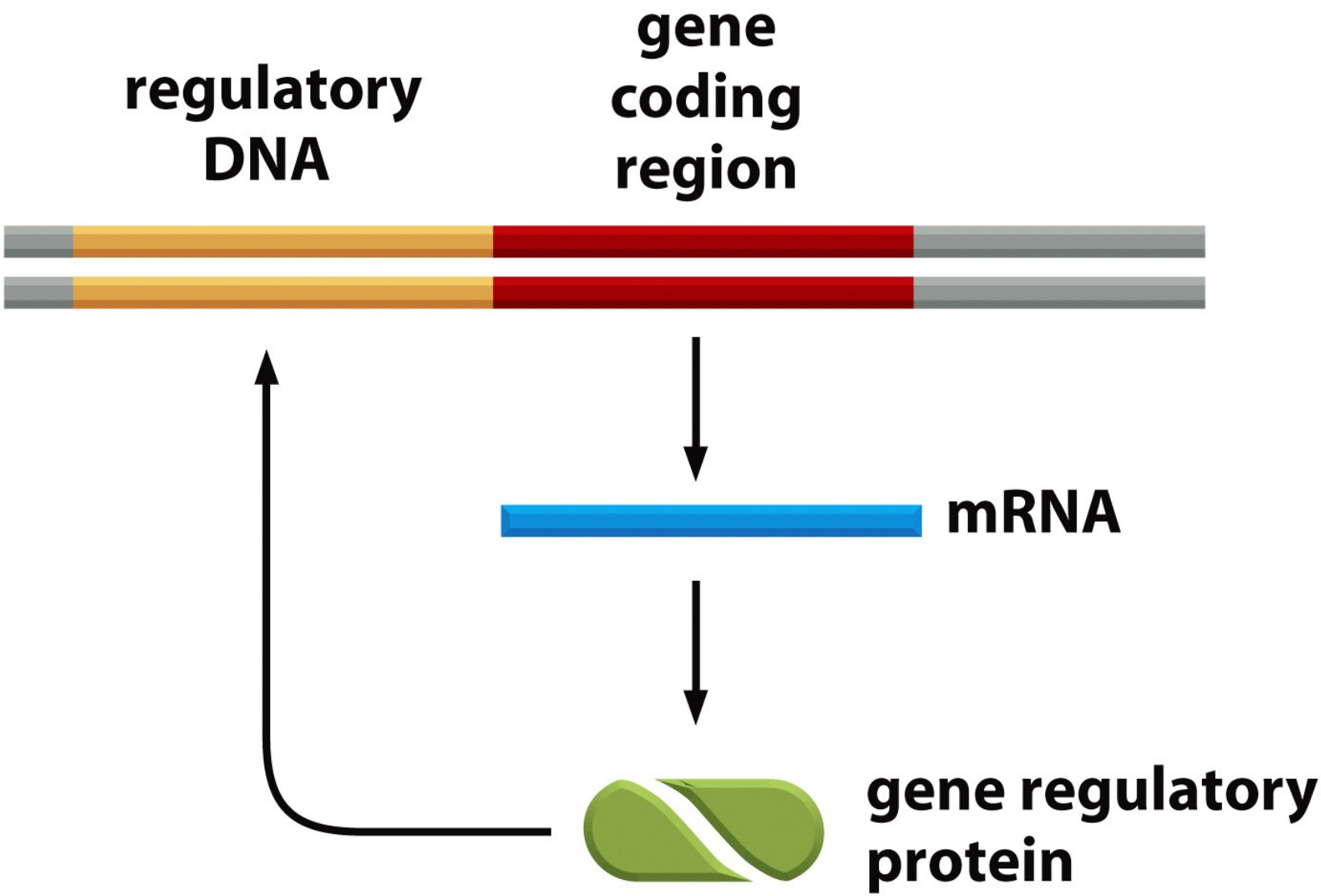


Figure 1-45 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Sequential Events by Proteins and Enzymes Are the Basis of Many Biological Signals