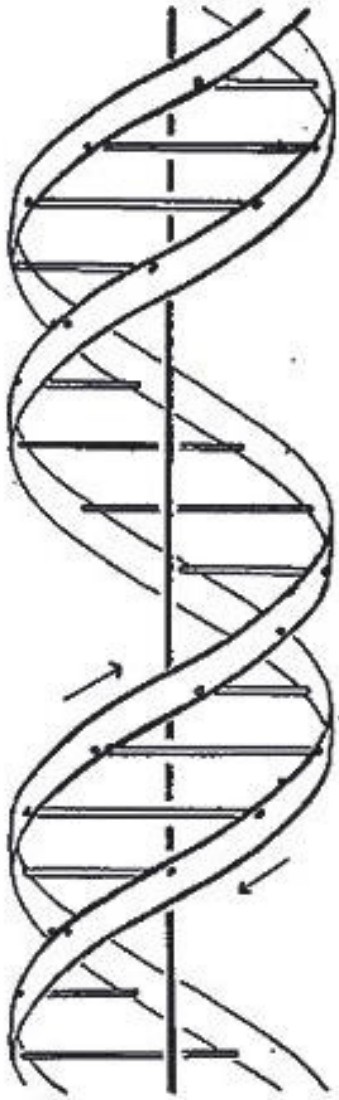


# Elements of Molecular Biology

Stephen Altschul

National Center for Biotechnology Information  
National Library of Medicine  
National Institutes of Health

# The Structure of DNA

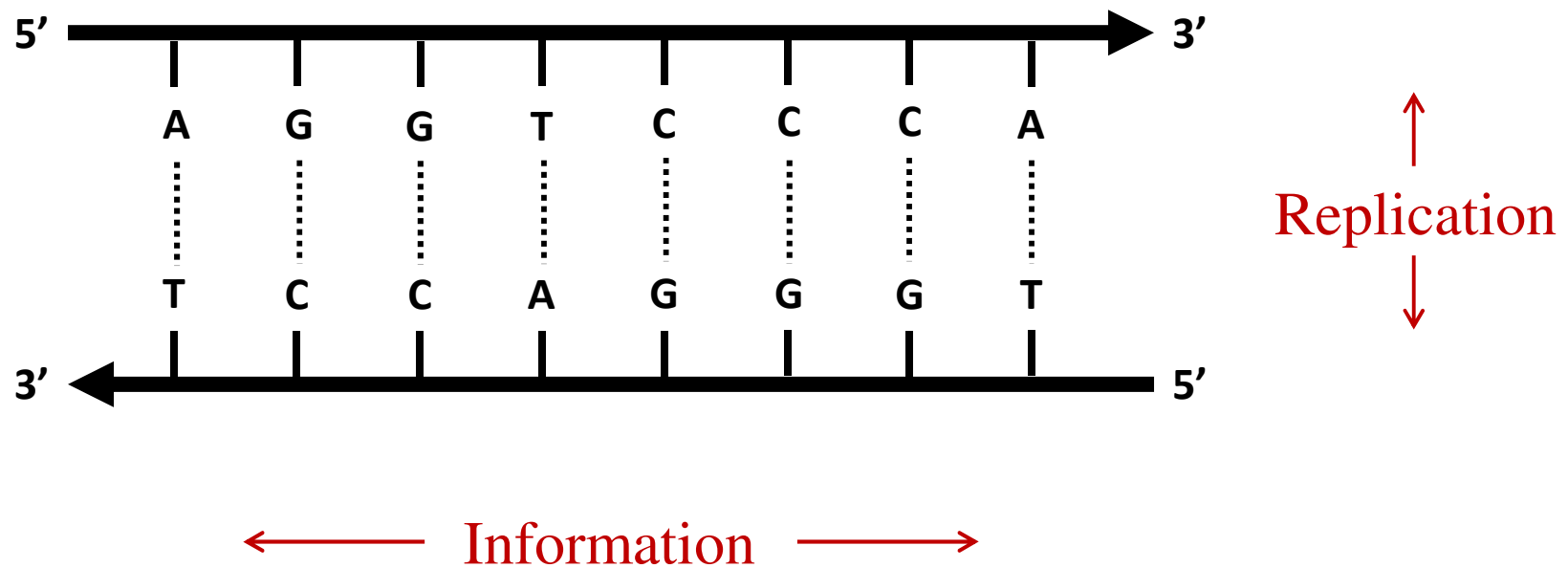


Watson, J.D. & Crick, F.H.C. (1953)  
“Molecular structure of nucleic acids –  
A structure for deoxyribose nucleic acid.”  
*Nature* **171**:737-738.

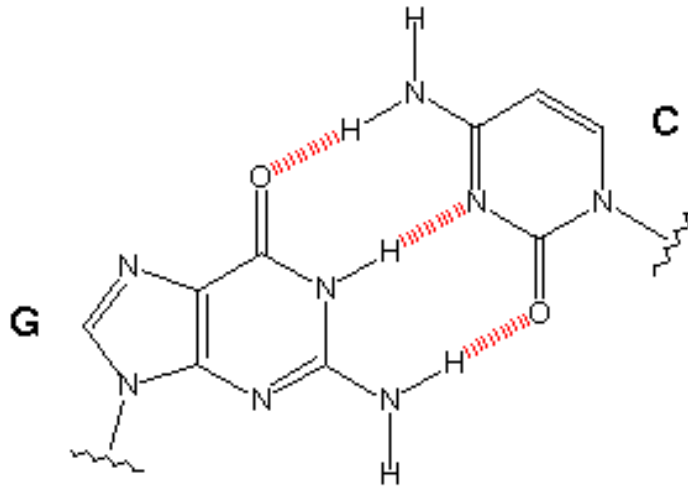
Watson, J.D. (1968) *The Double Helix*.  
Atheneum: New York, NY.

Judson, H.F. (1996) *The Eighth Day of  
Creation*. Cold Spring Harbor Laboratory  
Press: Cold Spring Harbor, NY.

# The Structure of DNA in the Abstract



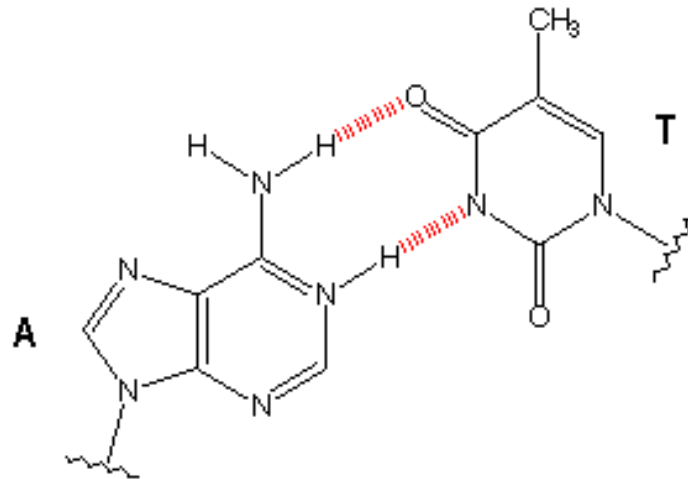
# Watson-Crick Base Pairs



## Purines

Guanine (G)

Adenine (A)



## Pyrimidines

Cytosine (C)

Thymine (T)

# DNA Informs Cells How to Make Proteins: The “Central Dogma”

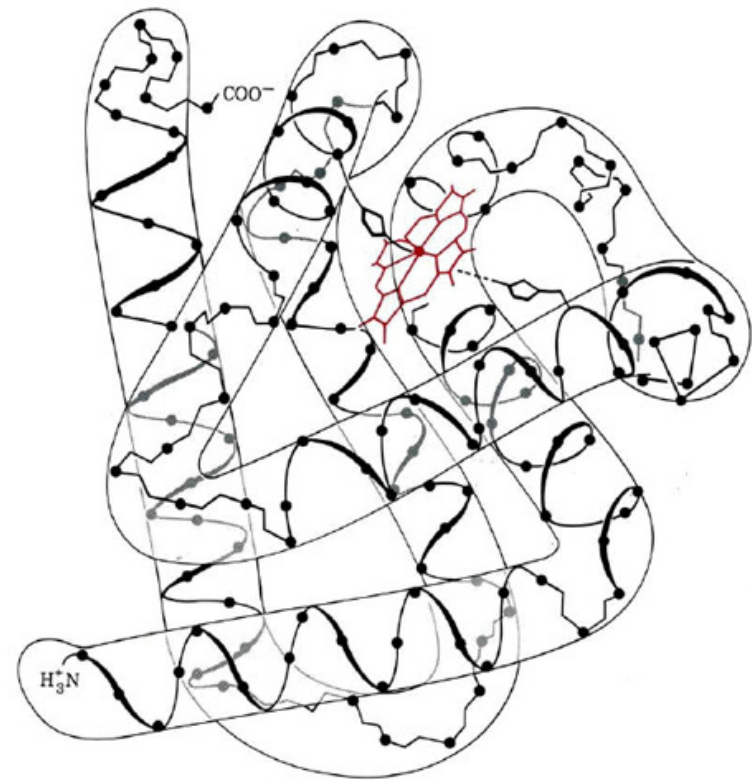
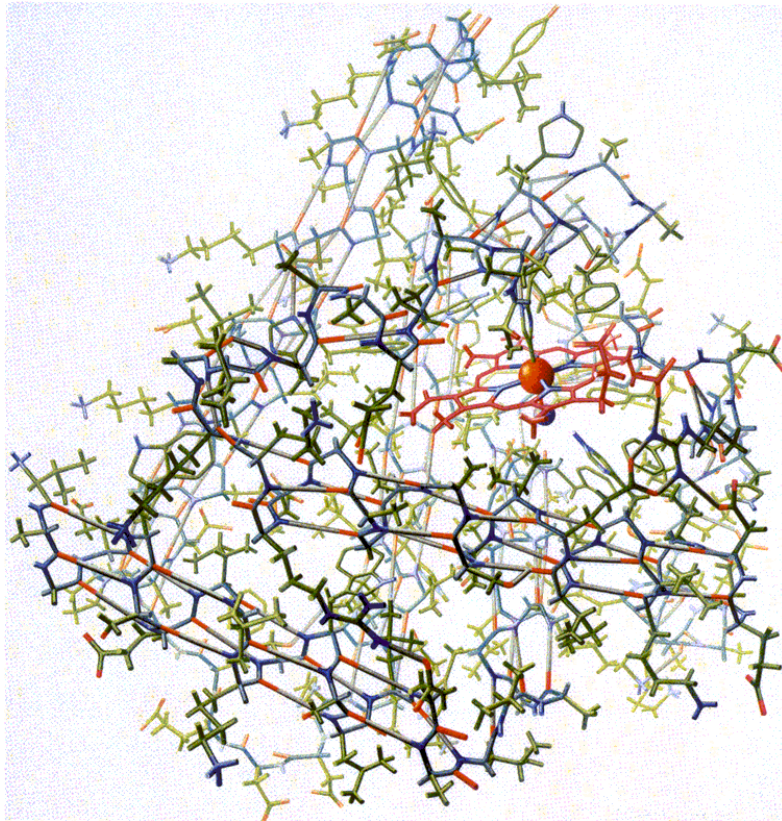
Replication

Transcription

Translation

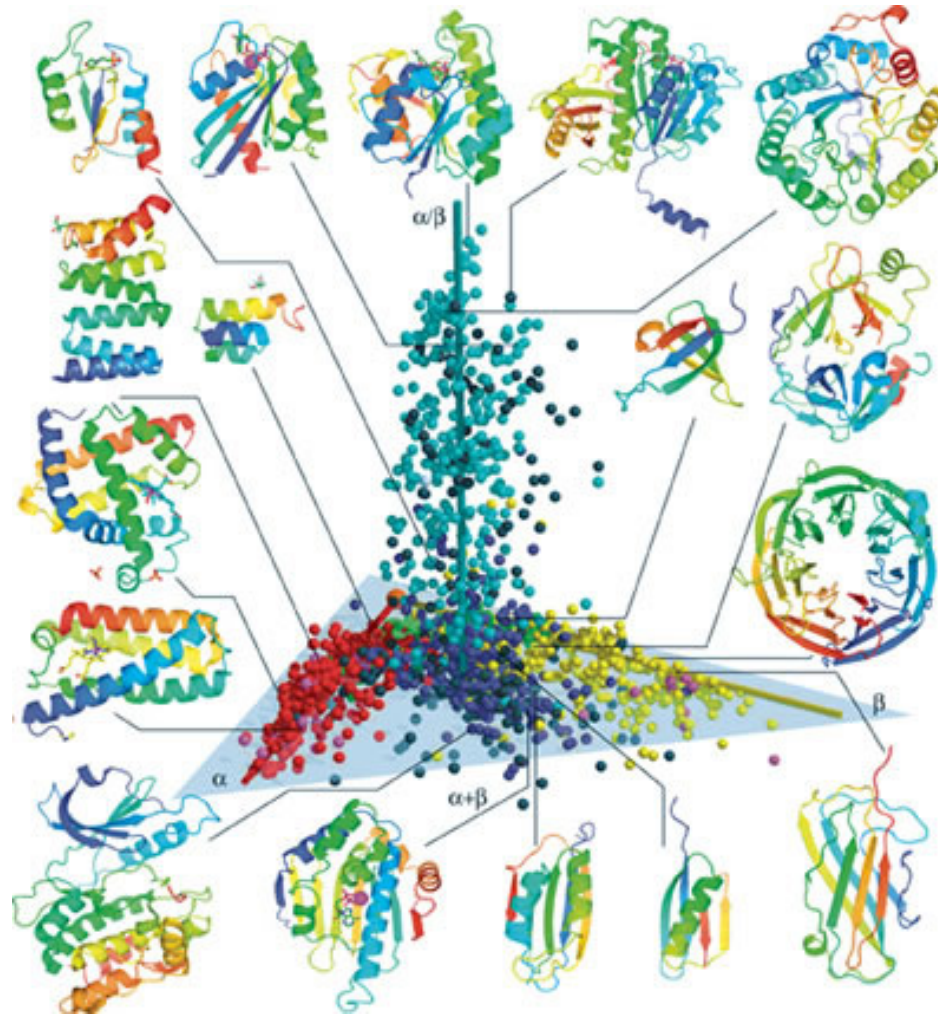


# The Three-Dimensional Structure of Sperm Whale Myoglobin



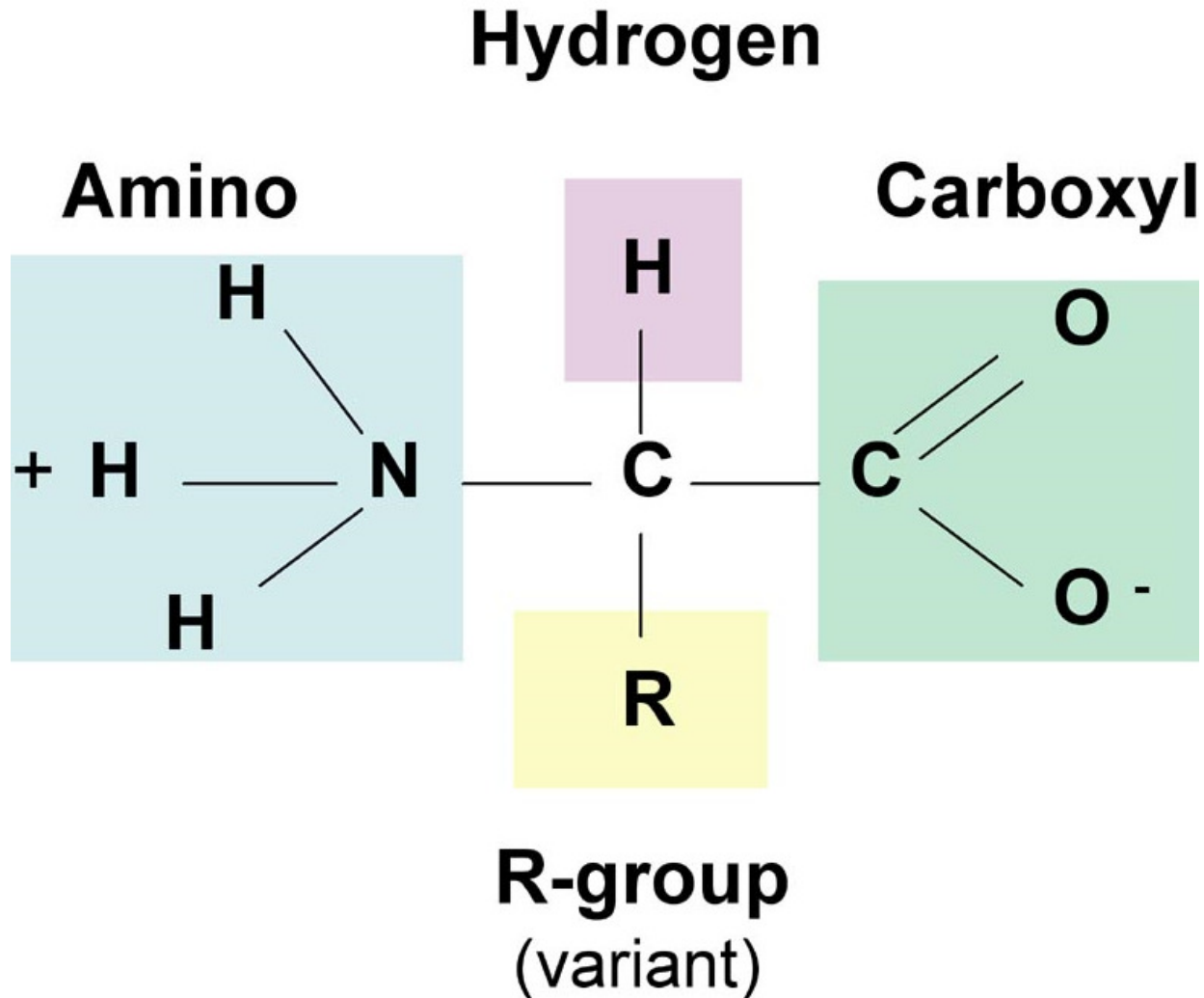
Kendrew, J.C. *et al.* (1958) “A three-dimensional model of the myoglobin molecule obtained by x-ray analysis.” *Nature* **181**: 662–666.

# A Variety of Protein Three-Dimensional Structures



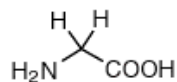
<http://www.lbl.gov/Publications/Currents/Archive/Apr-01-2005.html>

# The Structure of an Amino Acid

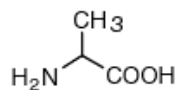


# Chemical Structures of the Twenty Common Amino Acids

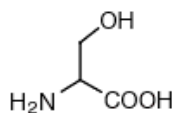
## Small



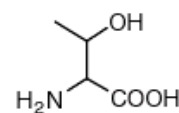
Glycine (Gly, G)  
MW: 57.05



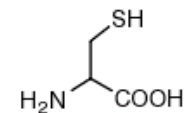
Alanine (Ala, A)  
MW: 71.09



Serine (Ser, S)  
MW: 87.08, pK<sub>a</sub> ~ 16

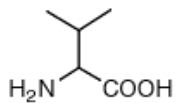


Threonine (Thr, T)  
MW: 101.11, pK<sub>a</sub> ~ 16

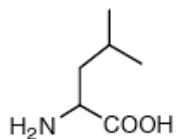


Cysteine (Cys, C)  
MW: 103.15, pK<sub>a</sub> = 8.35

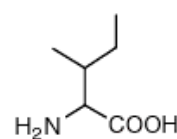
## Hydrophobic



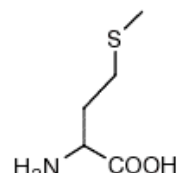
Valine (Val, V)  
MW: 99.14



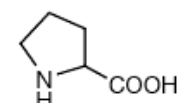
Leucine (Leu, L)  
MW: 113.16



Isoleucine (Ile, I)  
MW: 113.16

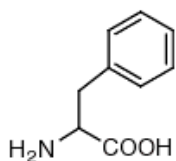


Methionine (Met, M)  
MW: 131.19

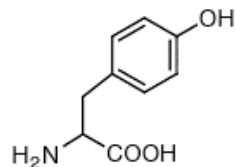


Proline (Pro, P)  
MW: 97.12

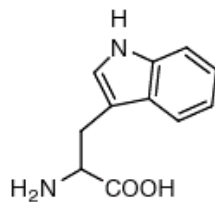
## Aromatic



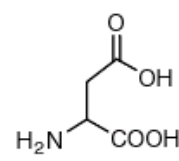
Phenylalanine (Phe, F)  
MW: 147.18



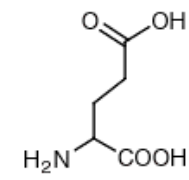
Tyrosine (Tyr, Y)  
MW: 163.18



Tryptophan (Trp, W)  
MW: 186.21

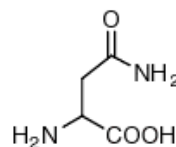


Aspartic Acid (Asp, D)  
MW: 115.09, pK<sub>a</sub> = 3.9

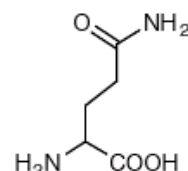


Glutamic Acid (Glu, E)  
MW: 129.12, pK<sub>a</sub> = 4.07

## Amide

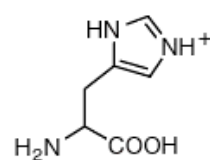


Asparagine (Asn, N)  
MW: 114.11

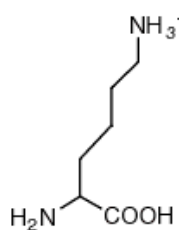


Glutamine (Gln, Q)  
MW: 128.14

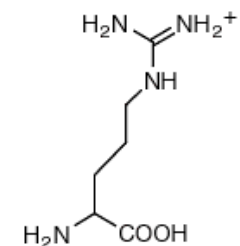
## Basic



Histidine (His, H)  
MW: 137.14, pK<sub>a</sub> = 6.04



Lysine (Lys, K)  
MW: 128.17, pK<sub>a</sub> = 10.79



Arginine (Arg, R)  
MW: 156.19, pK<sub>a</sub> = 12.48

# The Twenty Common Amino Acids

One-letter code	Name	One-letter code	Name
A	Alanine	M	Methionine
C	Cysteine	N	Asparagine
D	Aspartic acid	P	Proline
E	Glutamic acid	Q	Glutamine
F	Phenylalanine	R	Arginine
G	Glycine	S	Serine
H	Histidine	T	Threonine
I	Isoleucine	V	Valine
K	Lysine	W	Tryptophan
L	Leucine	Y	Tyrosine

# The Genetic Code

2nd→ 1st ↓	U	C	A	G	3rd ↓
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



Marshall  
Nirenberg  
1927-2010