Bio 37
Structural Biology

Williamson

Fall, 2009

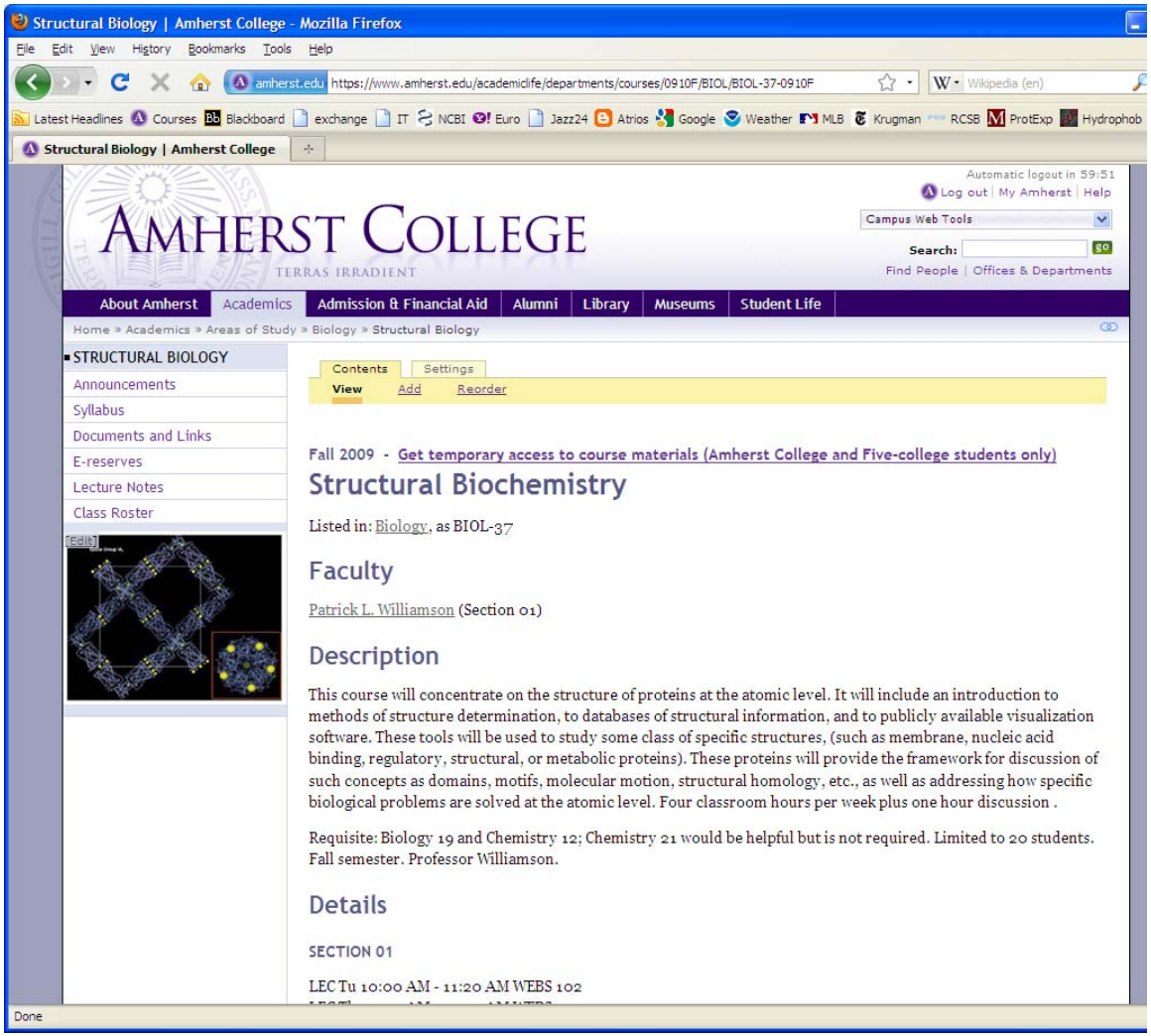
The first day

Philosophy

- Molecular explanations of biological processes
- Hypotheses – no and yes
- Evolution and particulars
- Visual science

- A course in the making

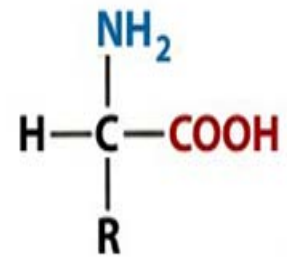
The course: The pieces



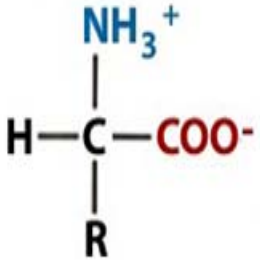
The Pregnant Pause…

Amino Acid Structure

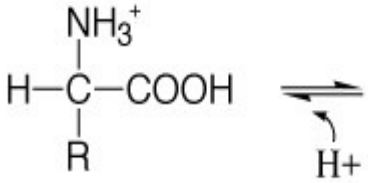
- α carbon and substituents
- Charged at amino and carboxyl terminal ends (of chains)
- Each aa residue is a dipole, and contributes to the dipole moment of the chain
- Water soluble as monomers, less so in polymer



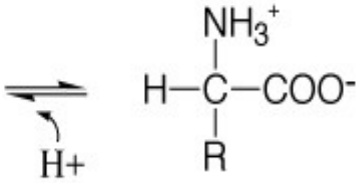
Un-ionized form of an amino acid



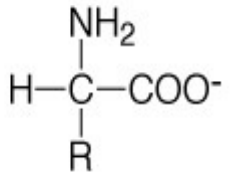
Dipolar ion (or zwitterion) form of an amino acid



Predominant form at pH 1



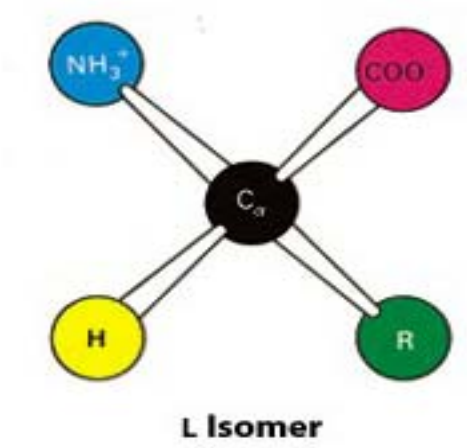
Predominant form at pH 7

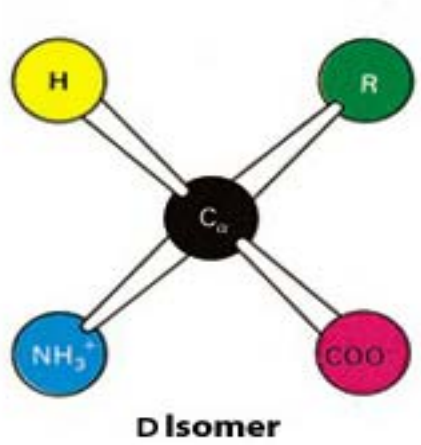


Predominant form at pH 11

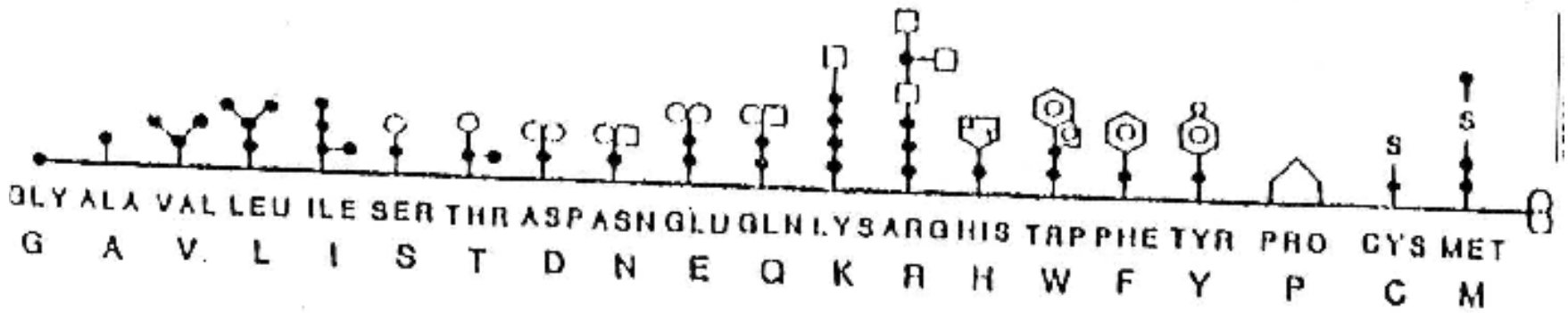
The alpha carbon is a chiral center

- The α carbon of all amino acids (except glycine) are chiral (and possibly others in side chain as well.)
- Naturally occurring amino acids are the L stereoisomer.



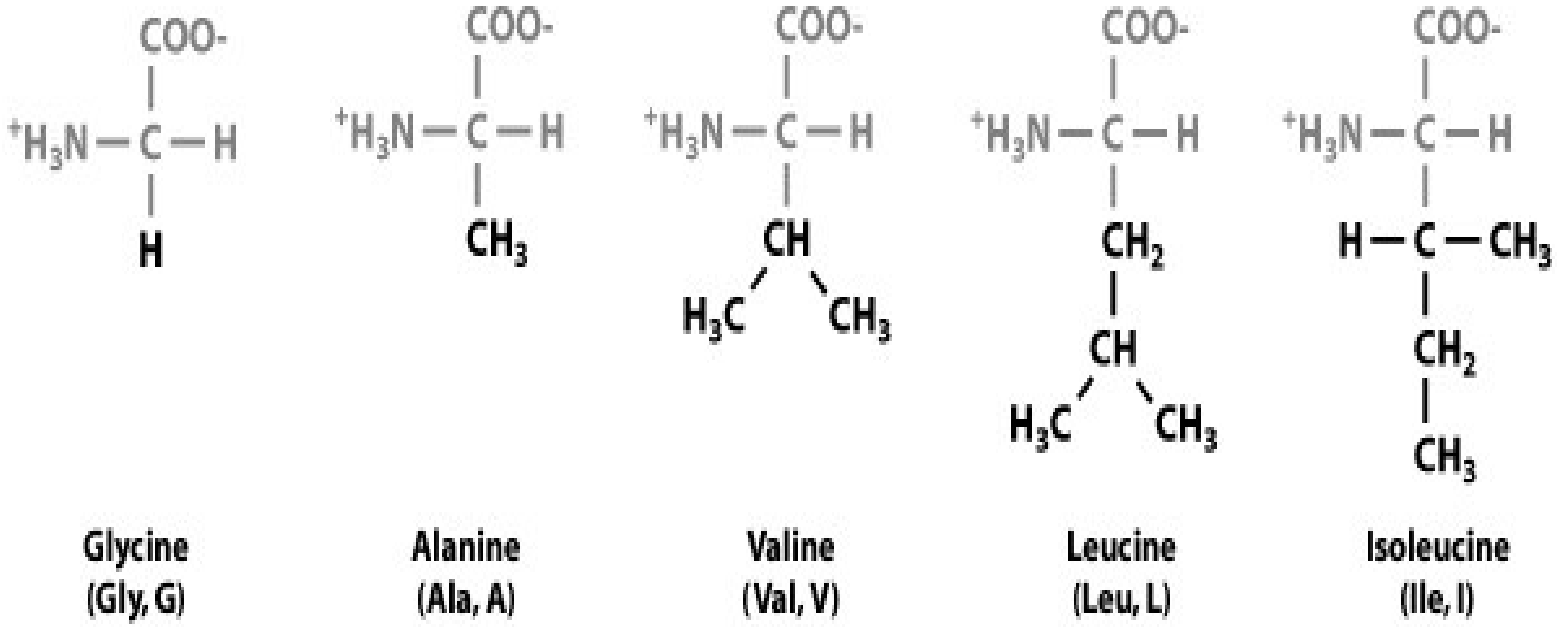


The sidechains: a quick summary (Thanks, Prof. O'Hara)



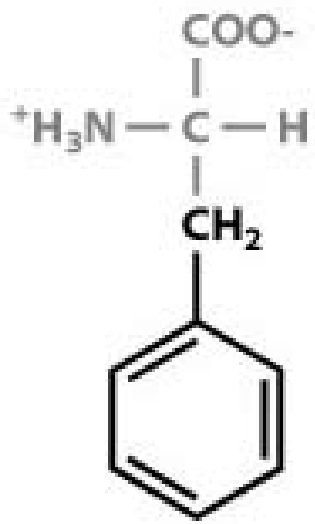
Short hand code for the structure of the individual amino acids

Aliphatic Side chains

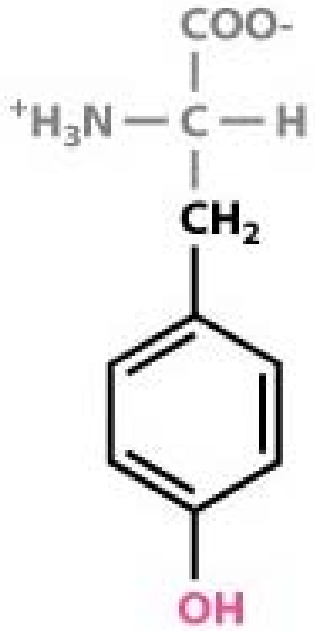


Val, Leu, and Ile are strongly hydrophobic amino acids

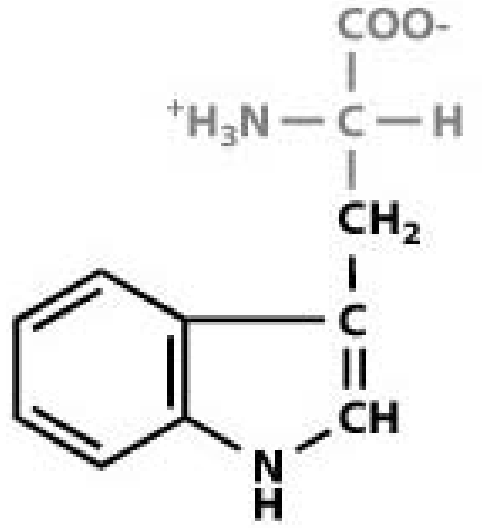
Aromatic Side chains



Phenylalanine
(Phe, F)

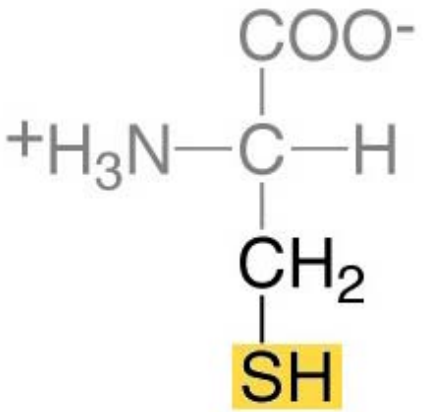


Tyrosine
(Tyr, Y)

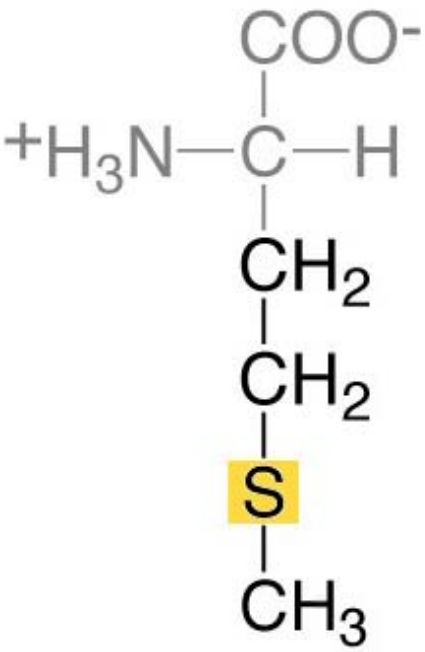


Tryptophan
(Trp, W)

Sulfur-containing sidechains

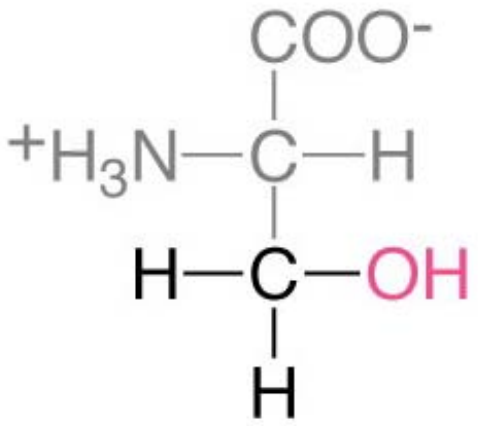


Cysteine
(Cys, C)

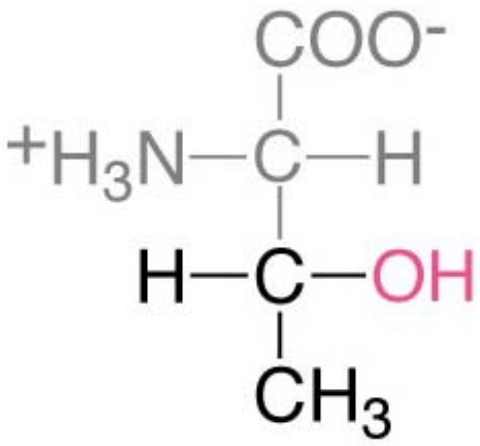


Methionine
(Met, M)

Hydroxyl sidechains



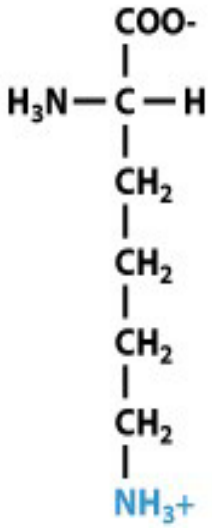
Serine
(Ser, S)



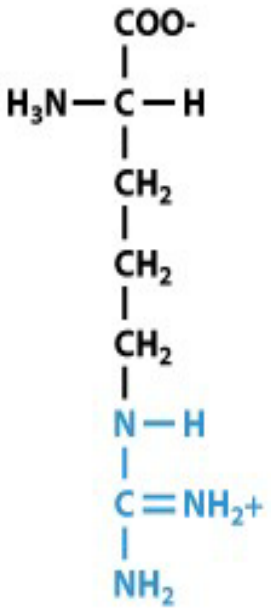
Threonine
(Thr, T)

…and tyrosine as well

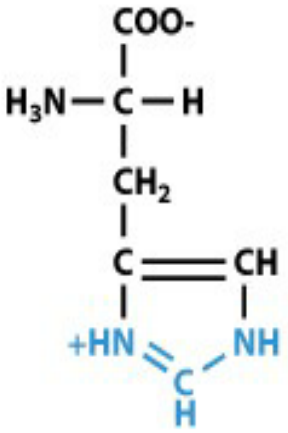
Basic Side chains



Lysine
(Lys, K)

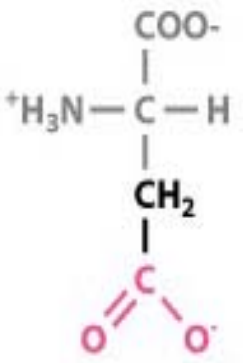


Arginine
(Arg, R)

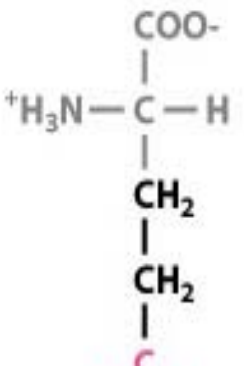


Histidine
(His, H)

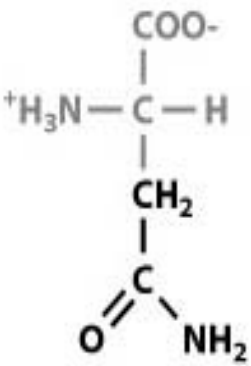
Anionic Side Chains & relations



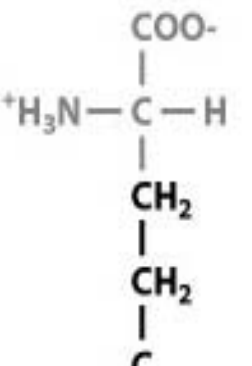
Aspartate
(Asp, D)



Glutamate
(Glu, E)



Asparagine
(Asn, N)



Glutamine
(Gln, Q)

ACIDIC AND BASIC AMINO ACIDS

Name	Polarity	Hydropathy	pK_1	pK_2	pK_r
Aspartate Asp- **D**	+0.80	-3.5	2.09	9.82	3.86 (3.65)
Glutamate Glu- **E**	+0.77	-3.5	2.19	9.67	4.25
Lysine Lys- **K**	+1.18	-3.9	2.18	8.95	10.53
Histidine His- **H**	-0.49	-3.2	1.82	9.17	6.00
Arginine Arg- **R**	+0.84	-4.5	2.17	9.04	12.5

Polarity Scale: Found in Aqueous environment (+ values)
Found in Hydrophobic environment (- values)
H.R. Guy (1984) Biophys. J. 47 61-70.

Hydropathy Scale: Found in Aqueous environment (- values)
Found in Hydrophobic environment (+ values).
Kyte & Doolittle (1982) J. Mol. Bio. 157, 105-132.

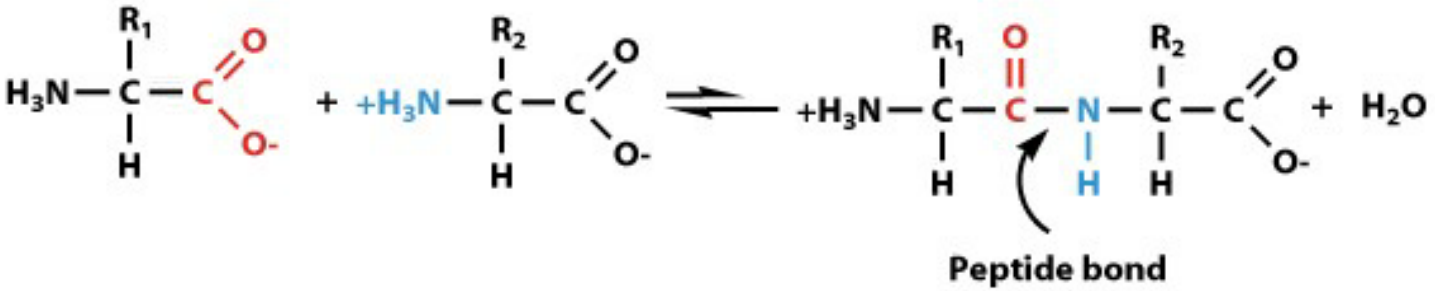
PREDICTED HYDROPHOBIC AMINO ACIDS

Name	Polarity	Hydropathy	pK_1	pK_2	pK_r
Alanine Ala- **A**	+0.06	+1.8	2.34	9.69	
Valine Val- **V**	-1.09	+4.2	2.32	9.62	
Leucine Leu- **L**	-1.21	+3.8	2.36	9.60	
Isoleucine Ile- **I**	-1.31	+4.5	2.36	9.68	
Proline Pro- **P**	+0.70	-1.6	1.99	10.96	
Phenylalanine Phe- **F**	-1.68	+2.8	1.83	9.13	
Tryptophan Trp- **W**	-0.88	-0.9	2.38	9.39	
Methionine Met- **M**	-1.23	+1.9	2.38	9.21	

PREDICTED HYDROPHILIC AMINO ACIDS

Name	Polarity	Hydropathy	pK_1	pK_2	pK_r
Glycine Gly- **G**	+0.41	-0.4	2.34	9.60	
Serine Ser- **S**	+0.50	-0.8	2.21	9.15	13.60
Threonine Thr- **T**	+0.27	-0.7	2.63 (2.11)	10.4 (9.62)	13.60
Cysteine Cys- **C**	-1.36	+2.5	1.71 (1.96)	10.8 (8.18)	8.3 (10.28)
Tyrosine Tyr- **Y**	-0.33	-1.3	2.20	9.11	10.5
Asparagine Asn- **N**	+0.48	-3.5	2.02	8.80	
Glutamine Gln- **Q**	+0.73	-3.5	2.17	9.13	

The peptide bond



- Two amino acids combine to form a dipeptide, three to form a tripeptide, several to form an oligopeptide, many to form a polypeptide, or protein
- Forward reaction is a dehydration, backward reaction is an hydrolysis
- Note energetics