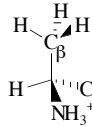




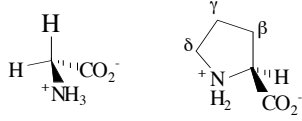
Ivuna and Murchison Meteorites

Vanilla



Alanine (Ala, A)

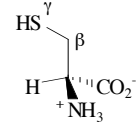
Structurally Strange



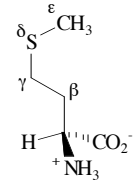
Glycine (Gly, G)

Proline (Pro, P)

S-Containing

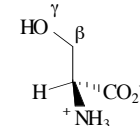


Cysteine (Cys, C)

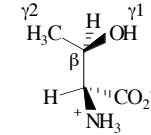


Methionine (Met, M)

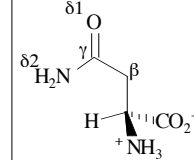
Polar, No Charge



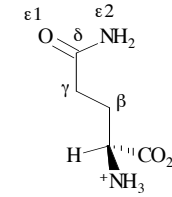
Serine (Ser, S)



Threonine (Thr, T)

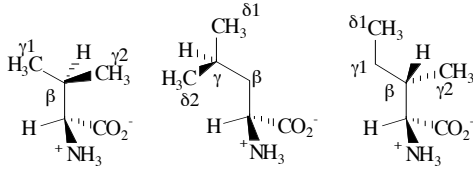


Asparagine (Asn, N)



Glutamine (Gln, Q)

Aliphatic Non-Polar

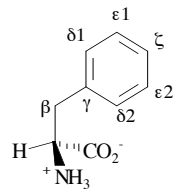


Valine (Val, V)

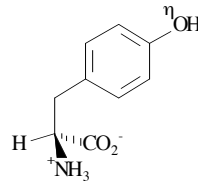
Leucine (Leu, L)

Isoleucine (Ile, I)

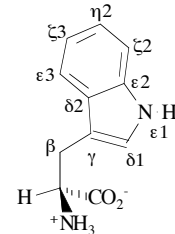
Aromatic "Non-Polar"



Phenylalanine (Phe, F)

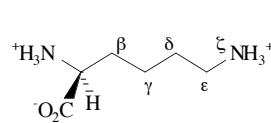


Tyrosine (Tyr, Y)

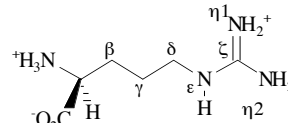


Tryptophan (Trp, W)

Basic

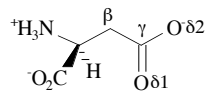


Lysine (Lys, K)

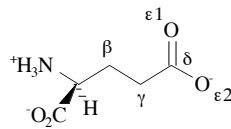


Arginine (Arg, R)

Acidic

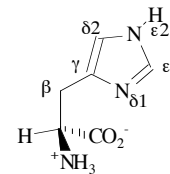


Aspartate (Asp, D)



Glutamate (Glu, E)

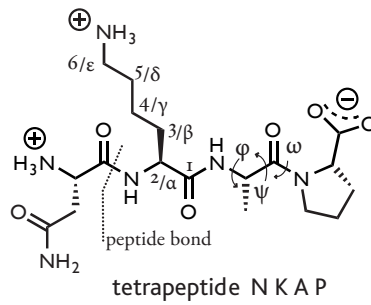
Gold



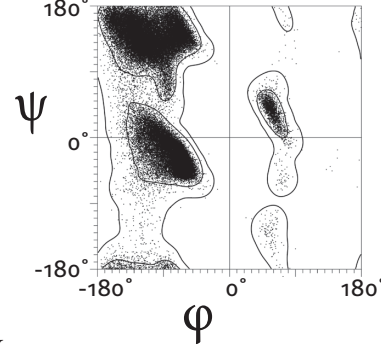
Histidine (His, H)

amino acids

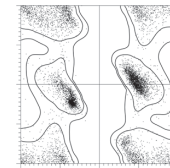
codons read from large to small, all molecules protonated at biological pH, side chain pK_a values rounded to one decimal place from CRC *handbook of chemistry and physics*. CRC press, 88th edition, 2007



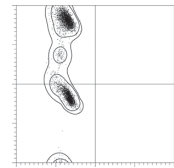
general residue Ramachandran plot



glycine



proline



plots adapted from Lovell S. C. *et al.* Structure validation by C_{α} geometry: ϕ, ψ and C_{β} deviation. *PROTEINS: structure, function, and genetics*. 2003;50(3):437-450.

Asn N NC(=O)CC U C A
 Lys K CCCC[NH3+] A G A
 Ser S CC(O)C U C G
 Arg R CCCNC(=[NH2+])N A G A
 Asp D CC(=O)[O-] U C A
 Glu E CC(=O)[O-] A G A
 Gly G CC(=O)N U C A G
 Ile I CC(C)C U C A
 Met M CC(S)C U G A
 Thr T CC(O)C U C A G
 Val V CC(C)C U C A G
 Ala A CC U C A G
 Gln Q CCC(N)=O A G A
 Arg R CCCNC(=[NH2+])N U C A G
 Phe F CC1=CC=CC=C1 U C A
 Leu L CC(C)C A G A
 Pro P C1CC(N)CC1 U C C A G

Adenine Nc1ncnc2[nH]cnc12
 Uracil O=c1cc[nH]c(=O)n1
 Guanine Nc1nc2[nH]cnc2c(=O)[nH]1
 Cytosine Nc1cc[nH]c(=O)n1

Kevin Lynagh, dept. dirigible flightcraft

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 Electronic copies are available at dirigibleflightcraft.com/cc/.

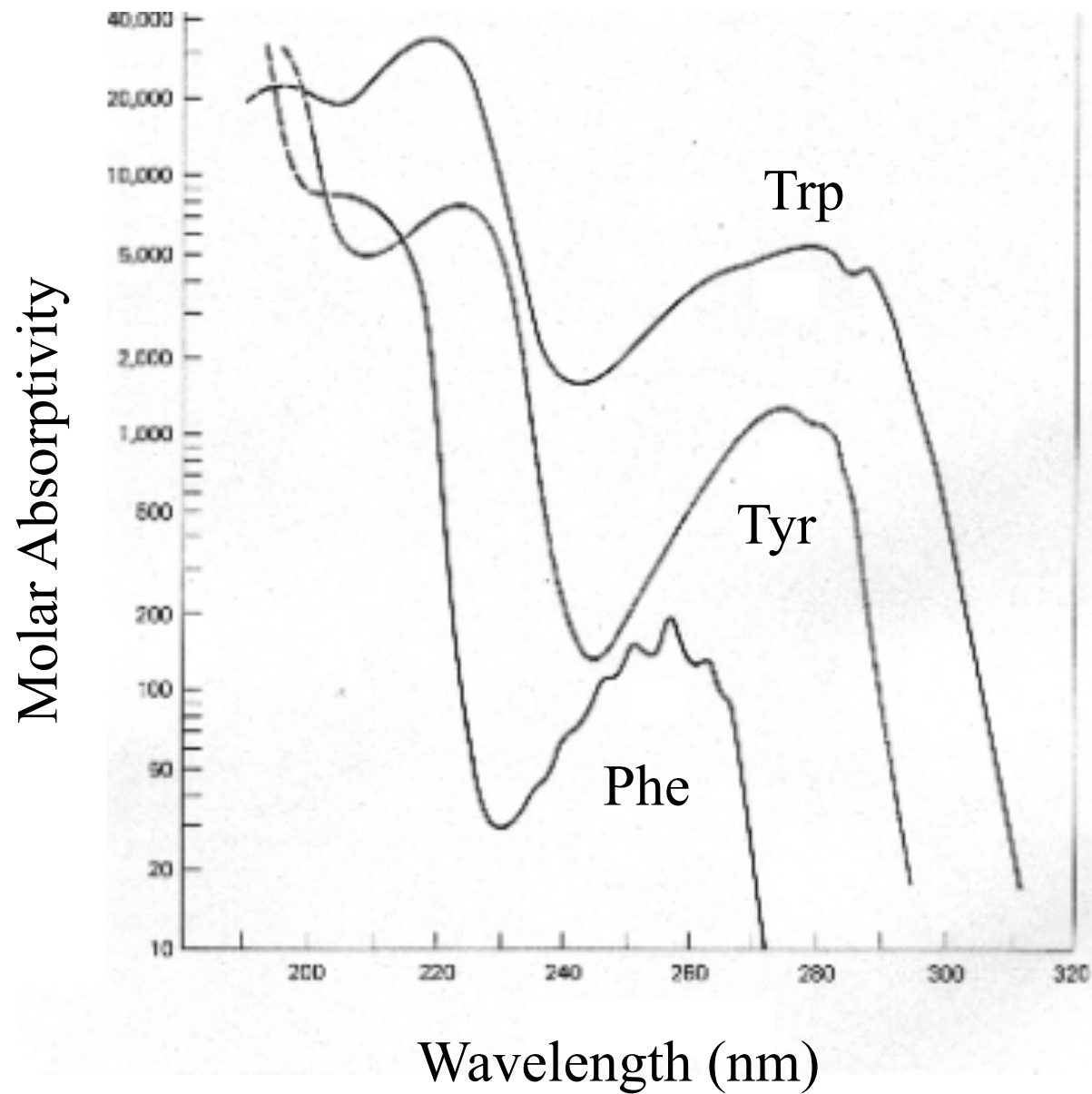
pK_a Data for Amino Acids

Molecule	Functionality	pK _a
Acetic acid	Carboxylic acid	4.7
Methylammonium ion	Ammonium group	10.6
Glycine	α-Ammonium group	9.6
Glycine	α-Carboxylic acid	2.3
Aspartic acid	γ-Carboxylic acid	4.0
Glutamic acid	δ-Carboxylic acid	4.4
Histidine	Imidazolium group	6.8
Cysteine	Sulfhydryl group	8.0
Tyrosine	Phenolic hydroxyl group	10.2
Lysine	ε-Ammonium group	10.7
Arginine	Guanidinium group	12.0

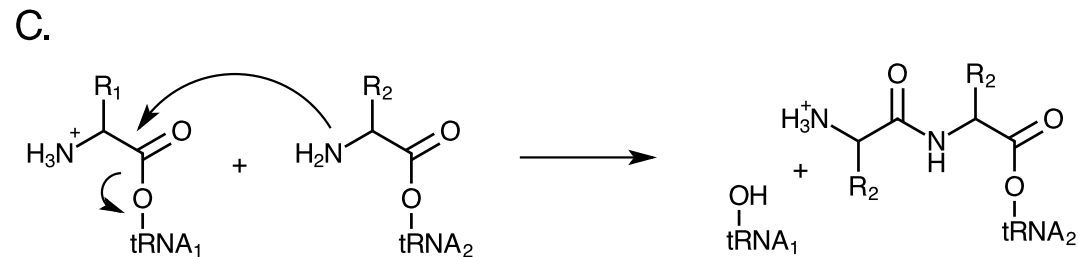
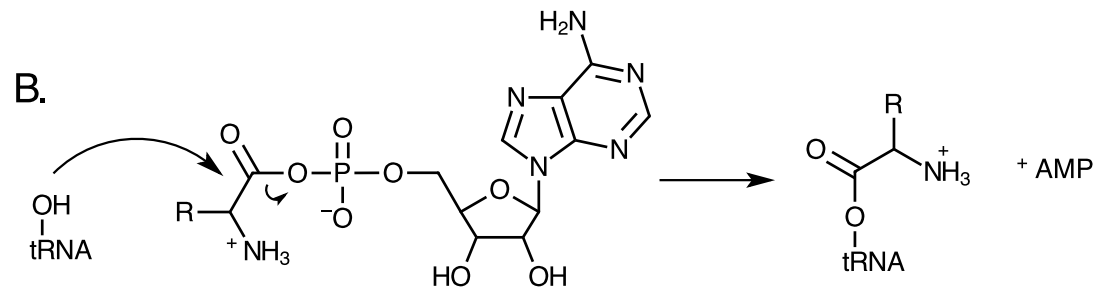
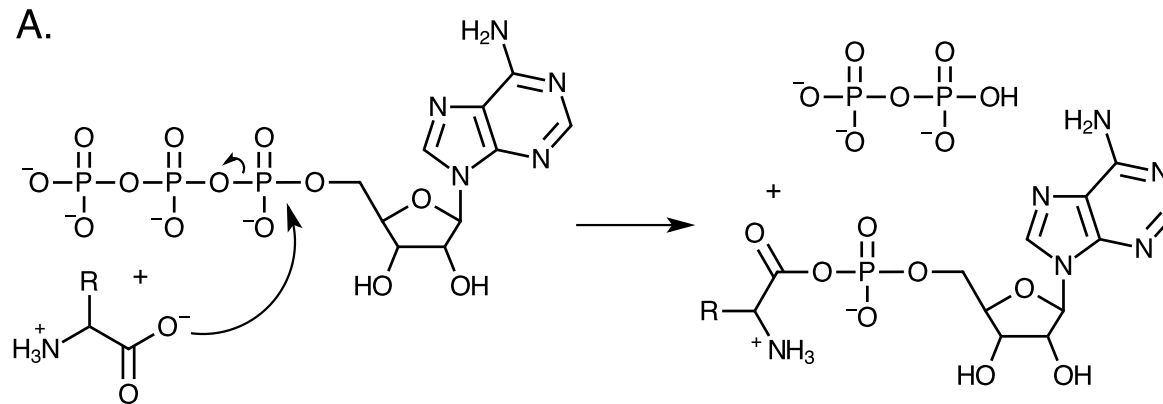
$\Delta\Delta G$ of Transfer to Octanol

Amino Acid	Abbreviations	$\Delta\Delta G_{\text{transfer}}$ (kcal/mol)
Isoleucine	Ile, I	-4.00
Leucine	Leu, L	-4.00
Valine	Val, V	-3.11
Phenylalanine	Phe, F	-2.05
Methionine	Met, M	-1.42
Tryptophan	Trp, W	-1.40
Alanine	Ala, A	-0.87
Cysteine	Cys, C	-0.34
Glycine	Gly, G	0
Tyrosine	Tyr, Y	1.09
Threonine	Thr, T	3.53
Serine	Ser, S	4.36
Asparagine	Asn, N	5.22
Histidine	His, H	5.63
Glutamine	Gln, Q	6.51
Lysine	Lys, K	6.52
Glutamic Acid	Glu, E	7.78
Aspartic Acid	Asp, D	9.71
Arginine	Arg, R	15.93

Absorbance Spectra of Aromatic Amino Acids



Biology makes an amide

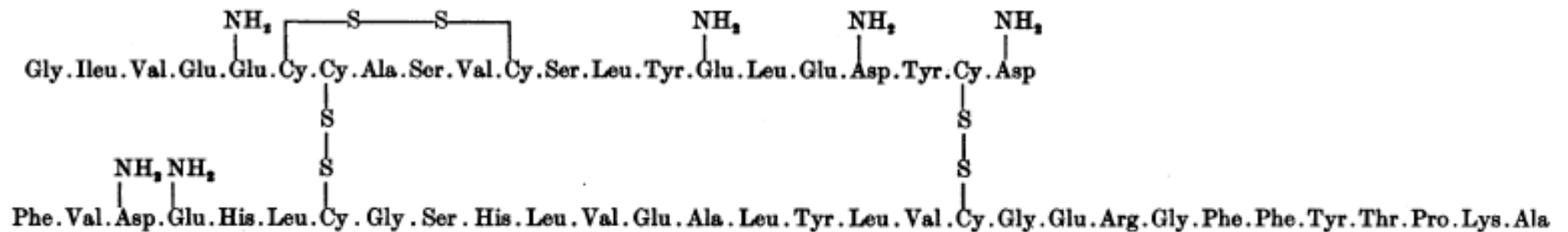


Disulfides in Insulin

The Disulphide Bonds of Insulin

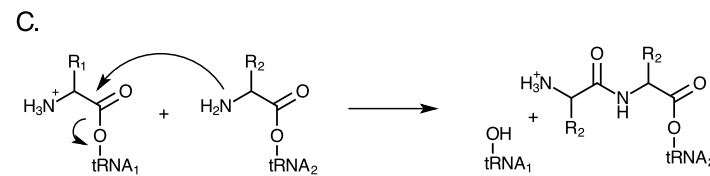
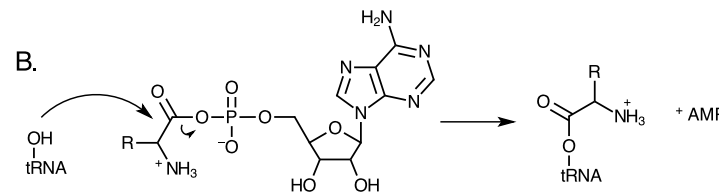
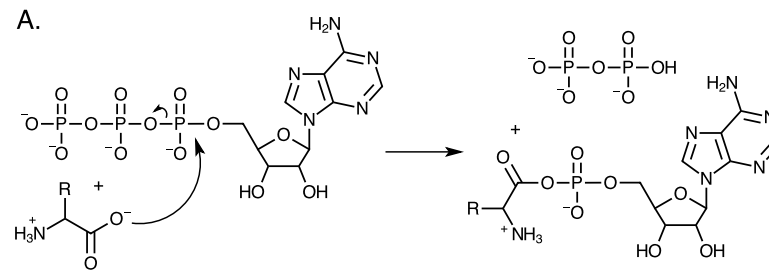
BY A. P. RYLE, F. SANGER,* L. F. SMITH* AND RUTH KITAI
Department of Biochemistry, University of Cambridge

Table 10. *The structure of insulin*

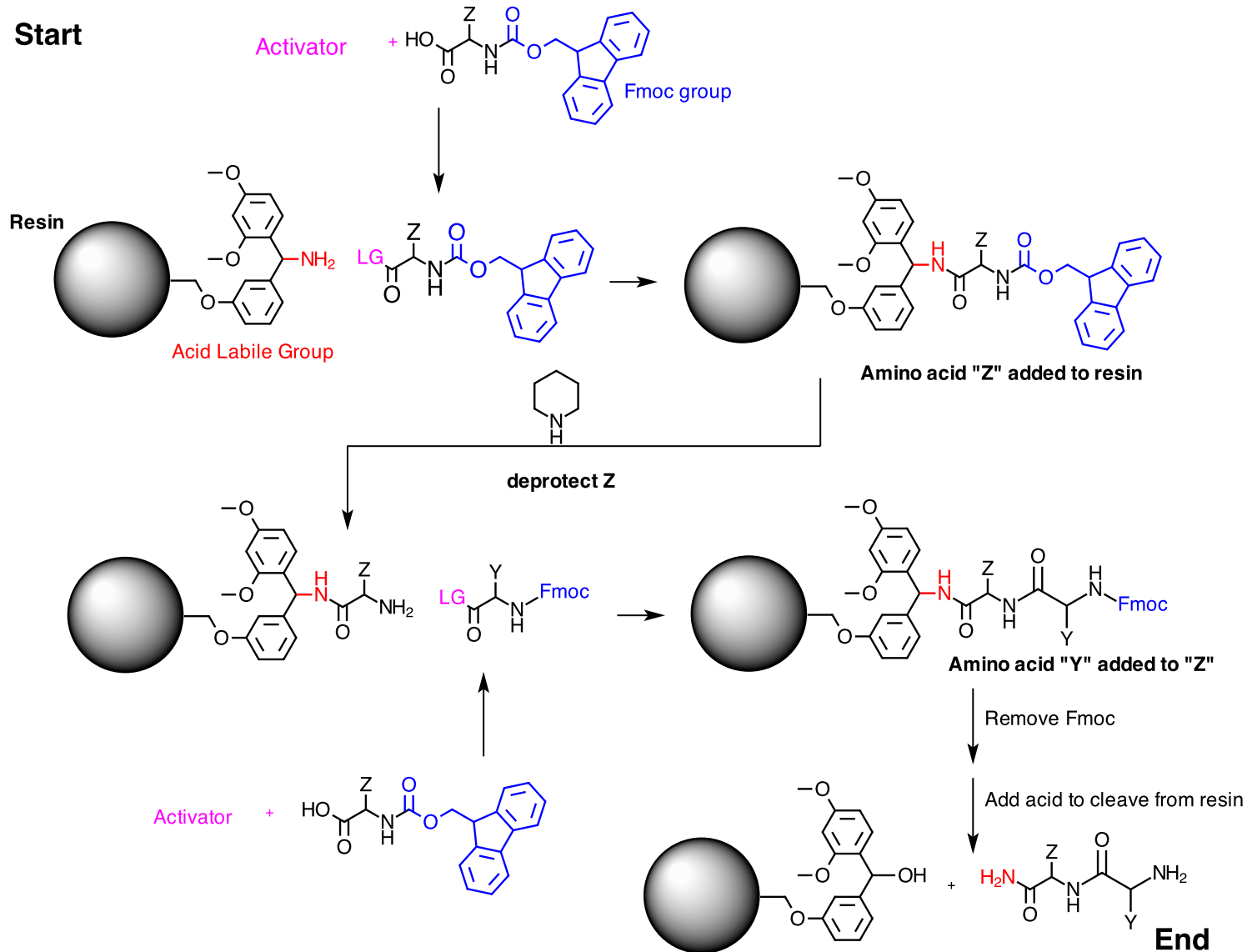


Biochem. J. **60**, 541 (1955)

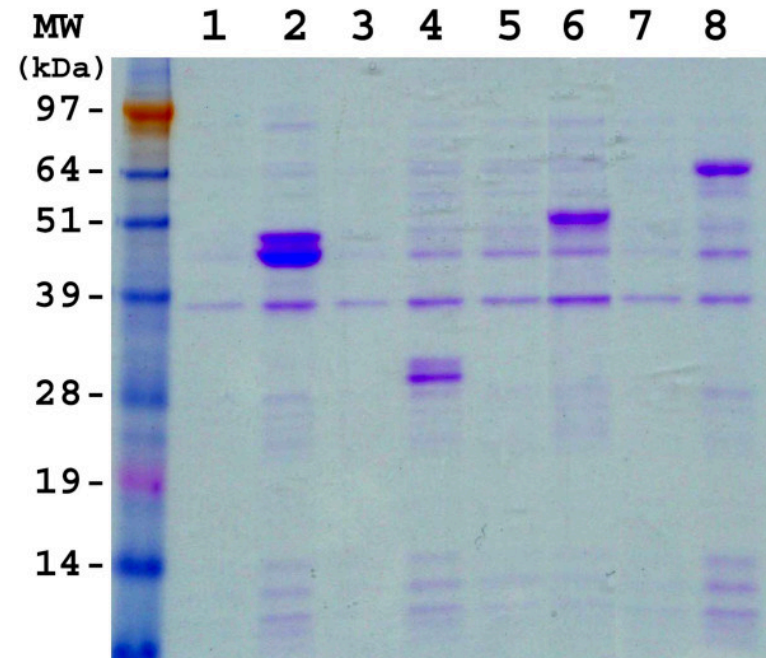
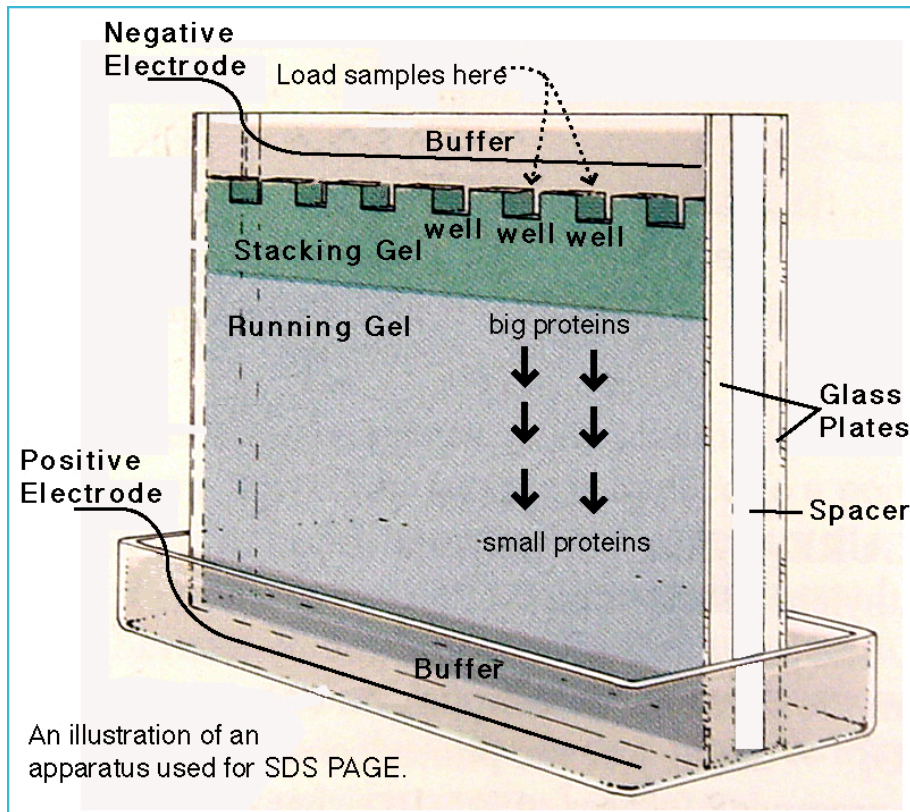
Biology makes an amide



Chemistry makes an amide



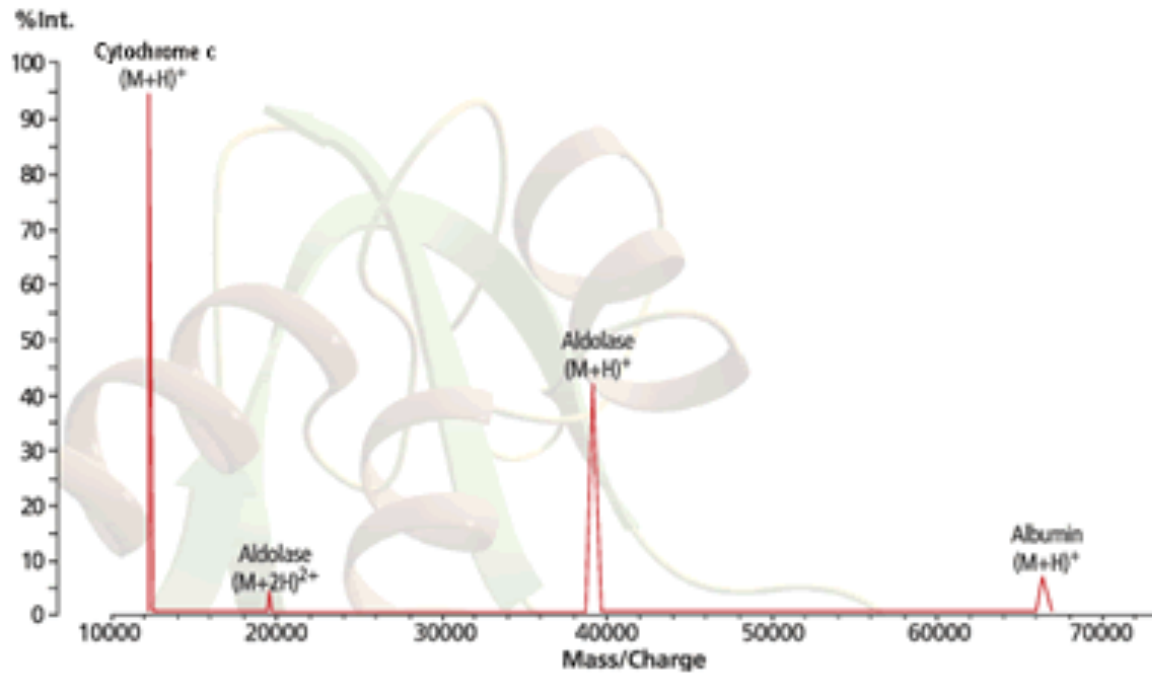
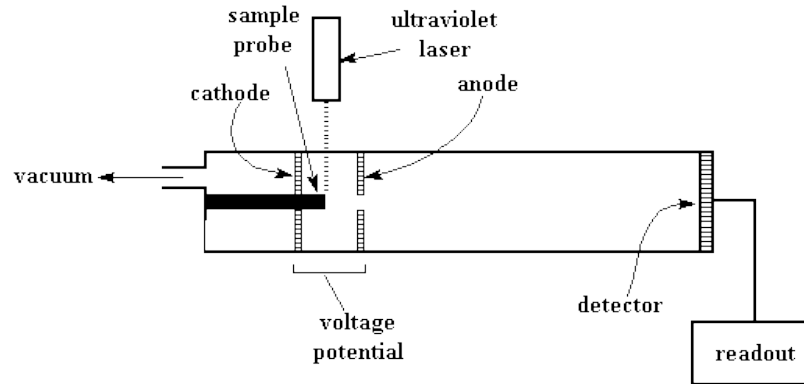
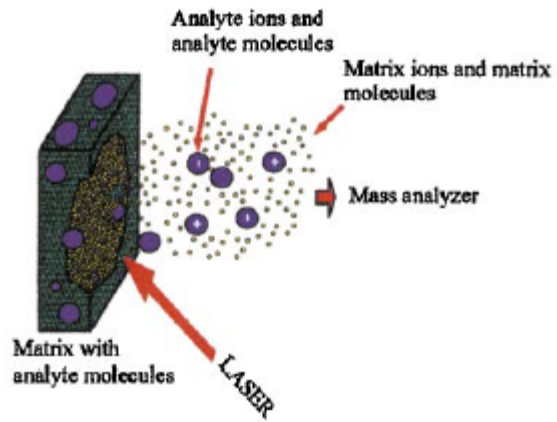
Denaturing Polyacrylamide Gel Electrophoresis



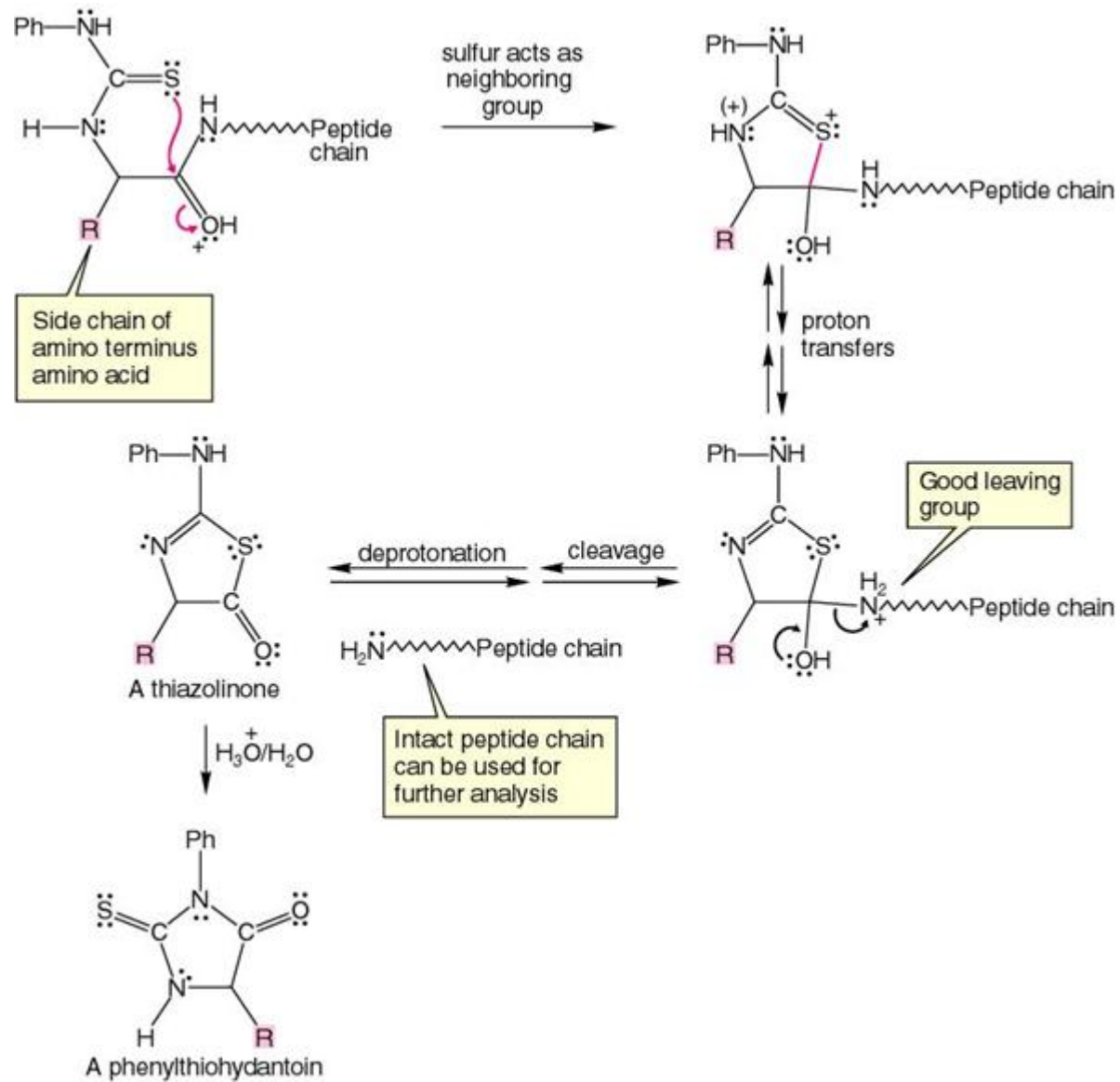
https://ww2.chemistry.gatech.edu/~lw26/bCourse_Information/4581/techniques/gel_elect/page_protein.html

<http://www.clinicalmolecularallergy.com/content/4/1/12/figure/F1>

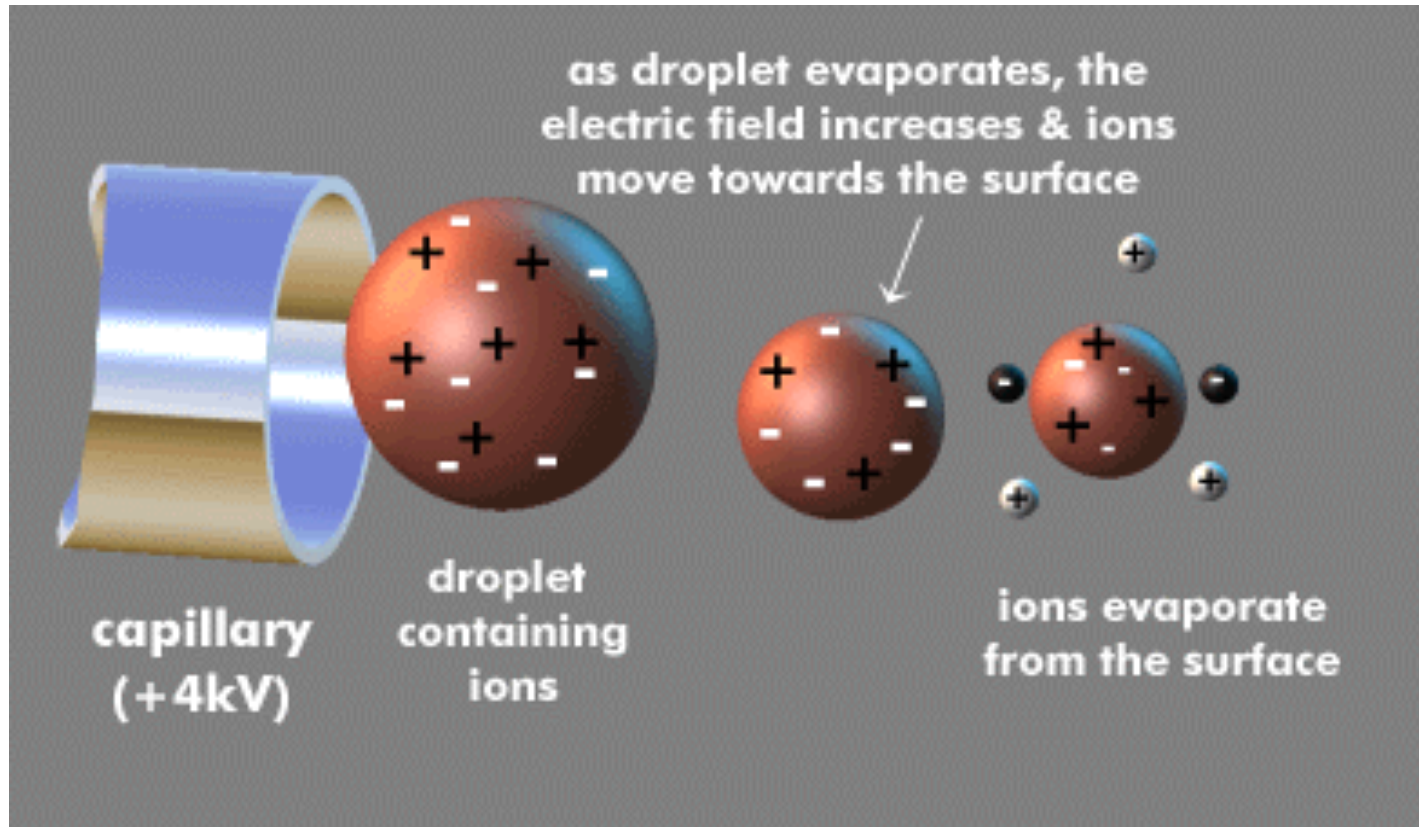
MALDI



Edman Degradation



Electron Spray Ionization



Electrospray ionization mass spectrometry (ESI MS)

