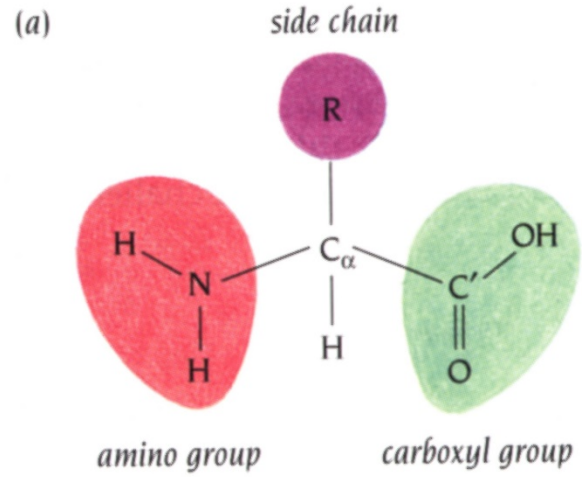


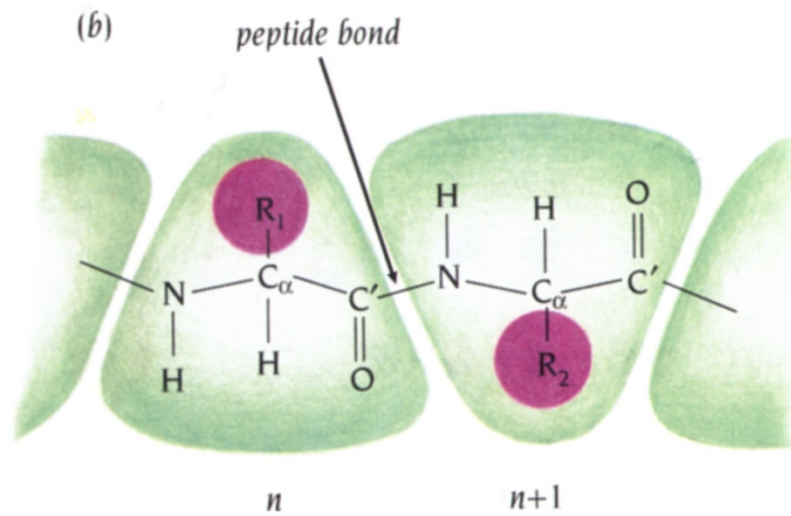
# Protein Structure

A quick reminder...

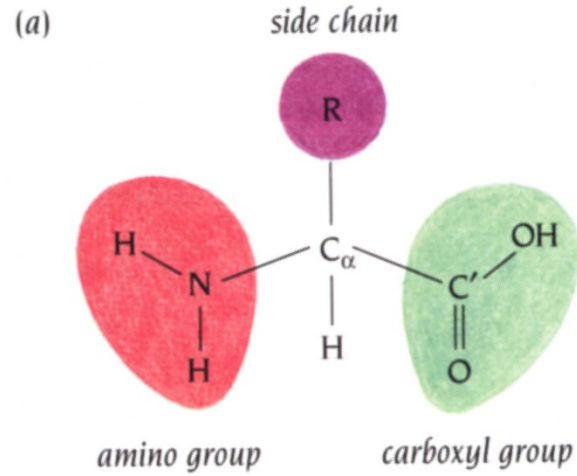
Amino acid	Three letter code	One letter code	Mnemonic
alanine	Ala	A	
arginine	Arg	R	<b>R</b> ginine
asparagine	Asn	N	asparagi <b>N</b> e
aspartic acid	Asp	D	aspar <b>D</b> ic
cysteine	Cys	C	
glutamic acid	Glu	E	glutam <b>E</b>
glutamine	Gln	Q	<b>Q</b> tamine
glycine	Gly	G	
histidine	His	H	
isoleucine	Ile	I	
leucine	Leu	L	
lysine	Lys	K	<b>K</b> is the letter before <b>L</b>
methionine	Met	M	
phenylalanine	Phe	F	<b>F</b> enylalanine
proline	Pro	P	
serine	Ser	S	
threonine	Thr	T	
tryptophan	Trp/Try	W	<b>tW</b> o rings (W has two Vs)
tyrosine	Tyr	Y	<b>tY</b> rosine
valine	Val	V	
asparagine or aspartic acid	Asx	B	A before G, <b>B</b> before <b>Z</b>
glutamine or glutamic acid	Glx	Z	A before G, <b>B</b> before <b>Z</b>
any amino acid	Unk	X	



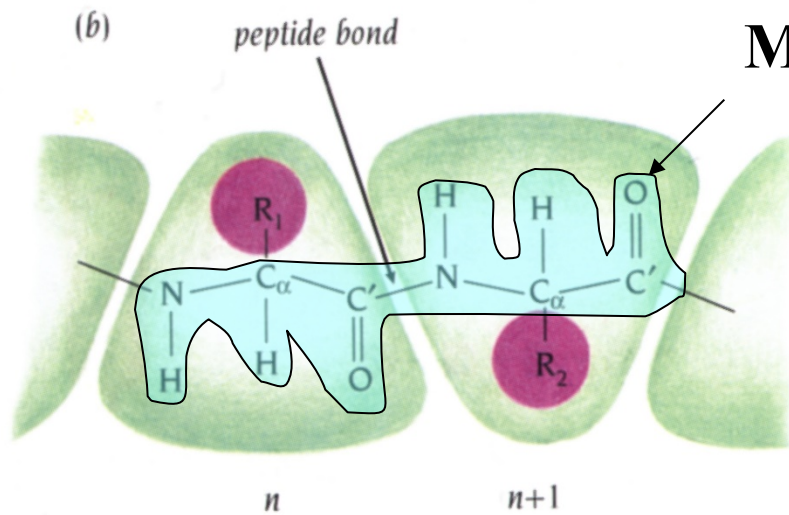
Covalent structure  
of an amino acid



Peptide units in protein  
chain.

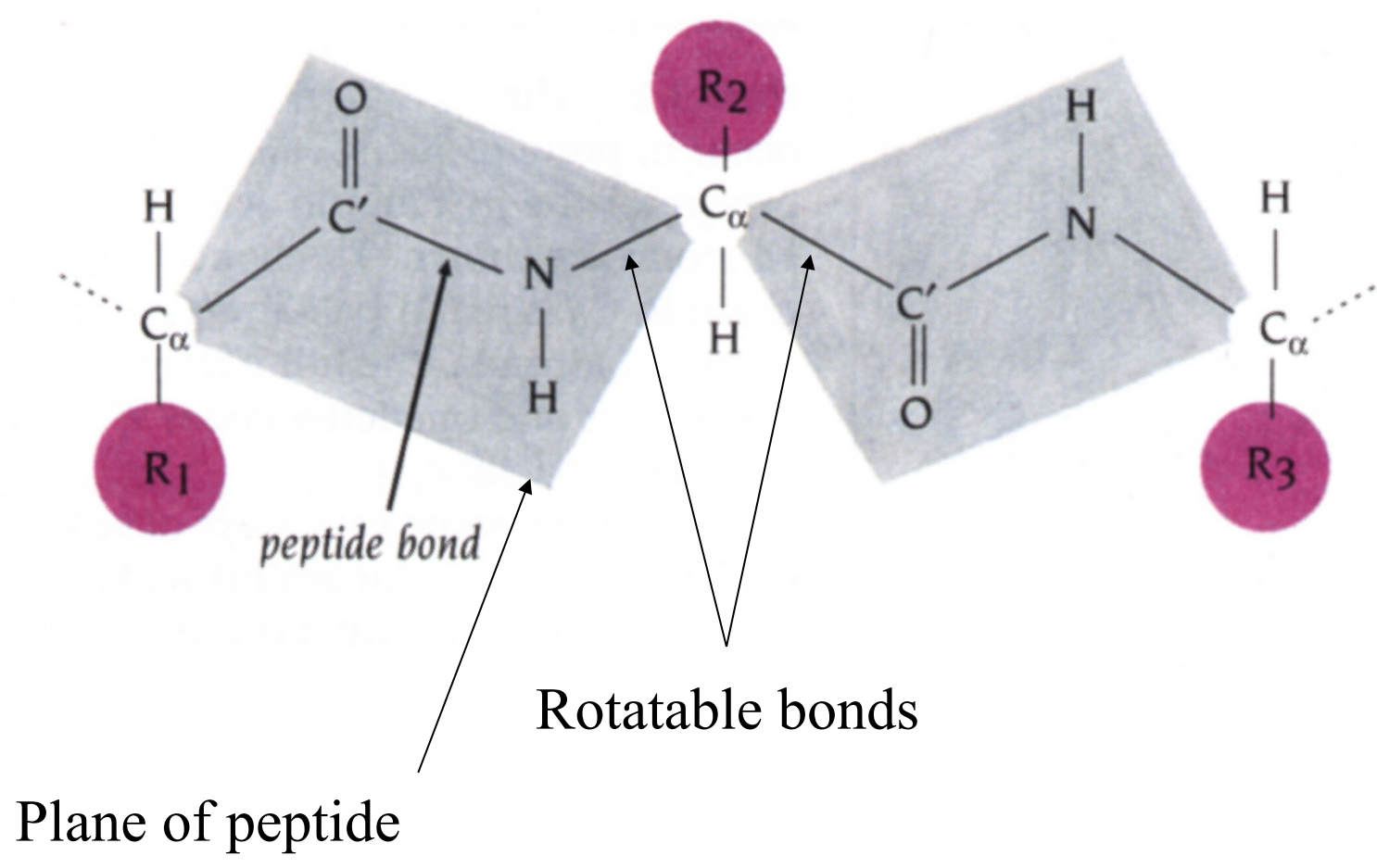


Covalent structure  
of an amino acid

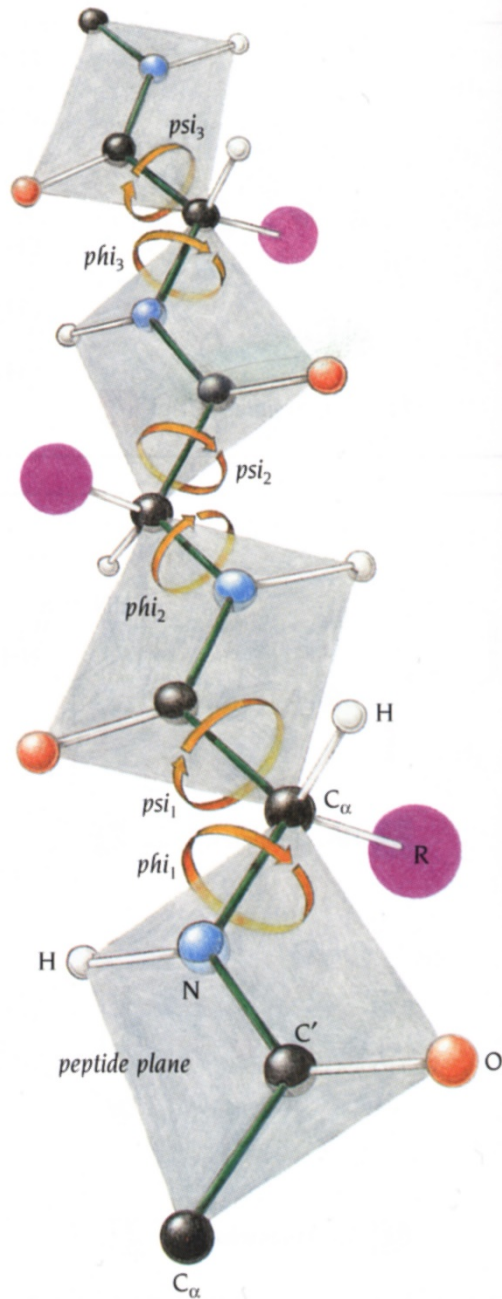


Peptide units in protein  
chain.

# Backbone torsion angles

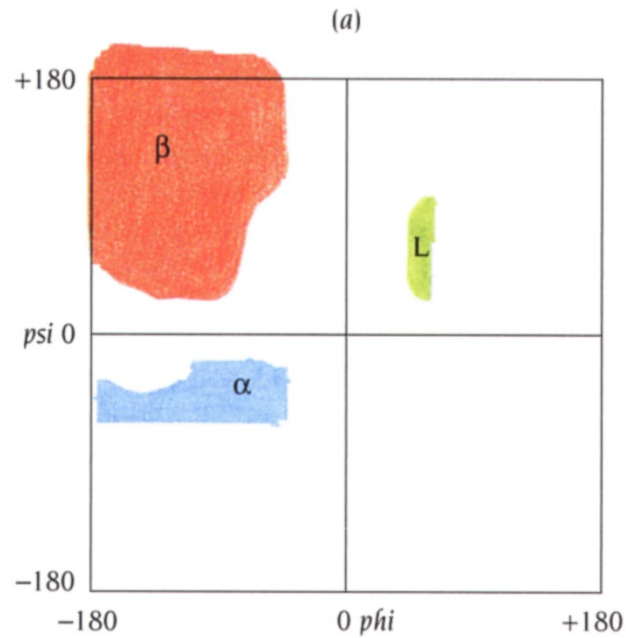


C  
↑  
N



The two rotatable mainchain bonds per peptide are called *phi* and *psi*

*Not all combinations of phi and psi are equally favoured*



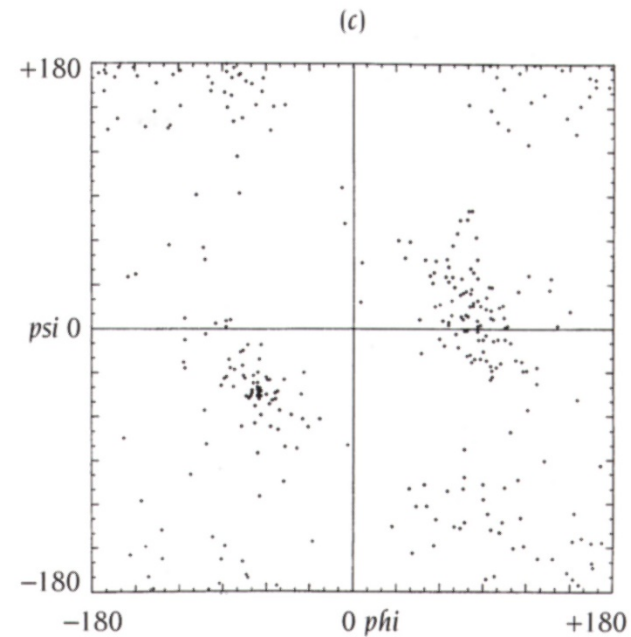
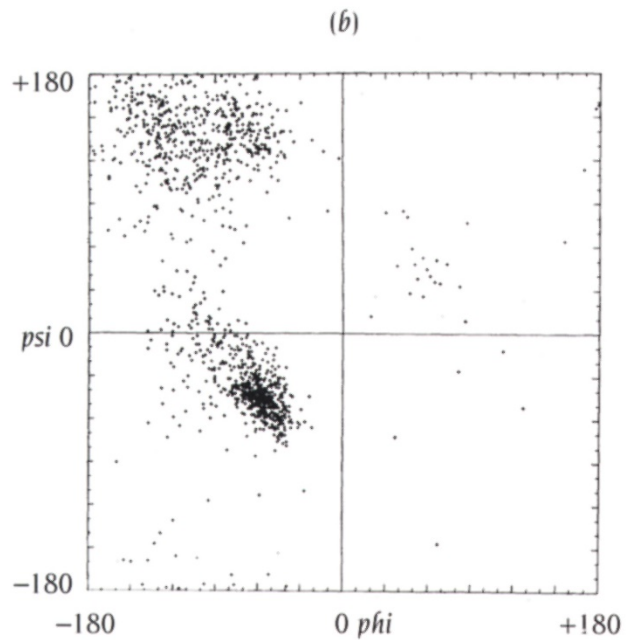
Plot  $\phi$  against  $\psi$  to identify preferred and disallowed backbone conformations.

(a) Allowed regions

(b) Plot for all amino acids except Glycine

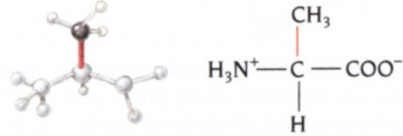
(c) Plot for Glycine

Known as a Ramachandran plot.





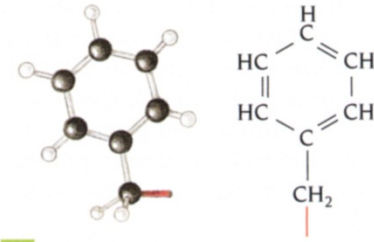
# Standard text-book classification of amino acid physico-chemical properties



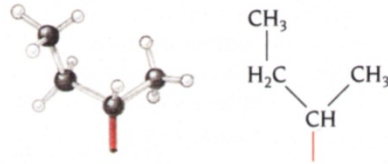
**A** Ala, Alanine



**V** Val, Valine



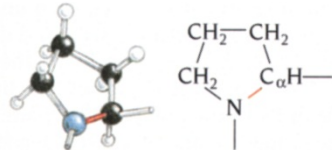
**F** Phe, Phenylalanine



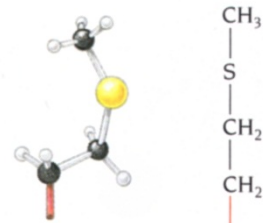
**I** Ile, Isoleucine



**L** Leu, Leucine

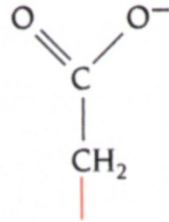
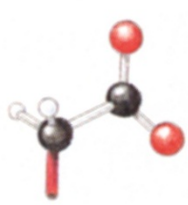


**P** Pro, Proline

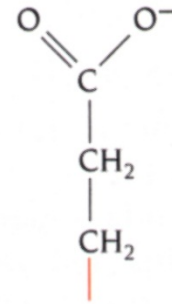
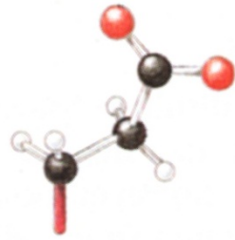


**M** Met, Methionine

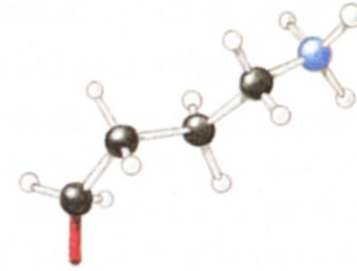
## Hydrophobic Amino Acids



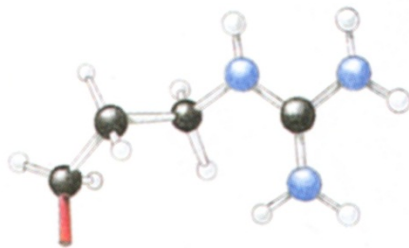
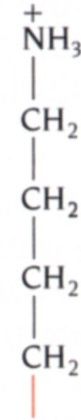
**D** Asp, Aspartic acid



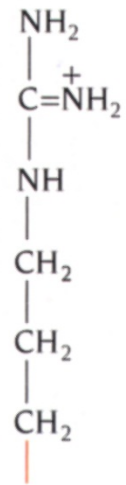
**E** Glu, Glutamic acid



**K** Lys, Lysine



**R** Arg, Arginine



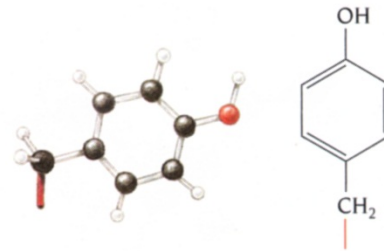
## Charged Amino Acids



**S** Ser, Serine



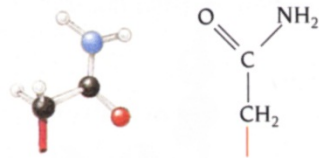
**T** Thr, Threonine



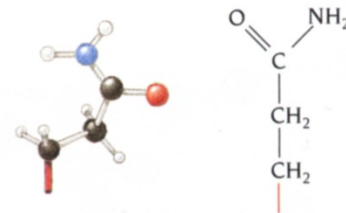
**Y** Tyr, Tyrosine



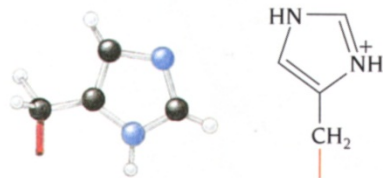
**C** Cys, Cysteine



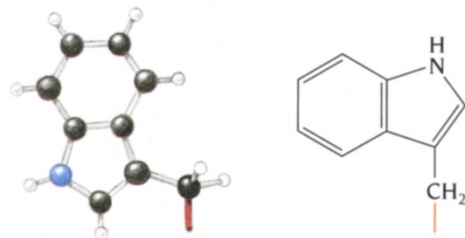
**N** Asn, Asparagine



**Q** Gln, Glutamine



**H** His, Histidine



**W** Trp, Tryptophan

## Polar Amino Acids

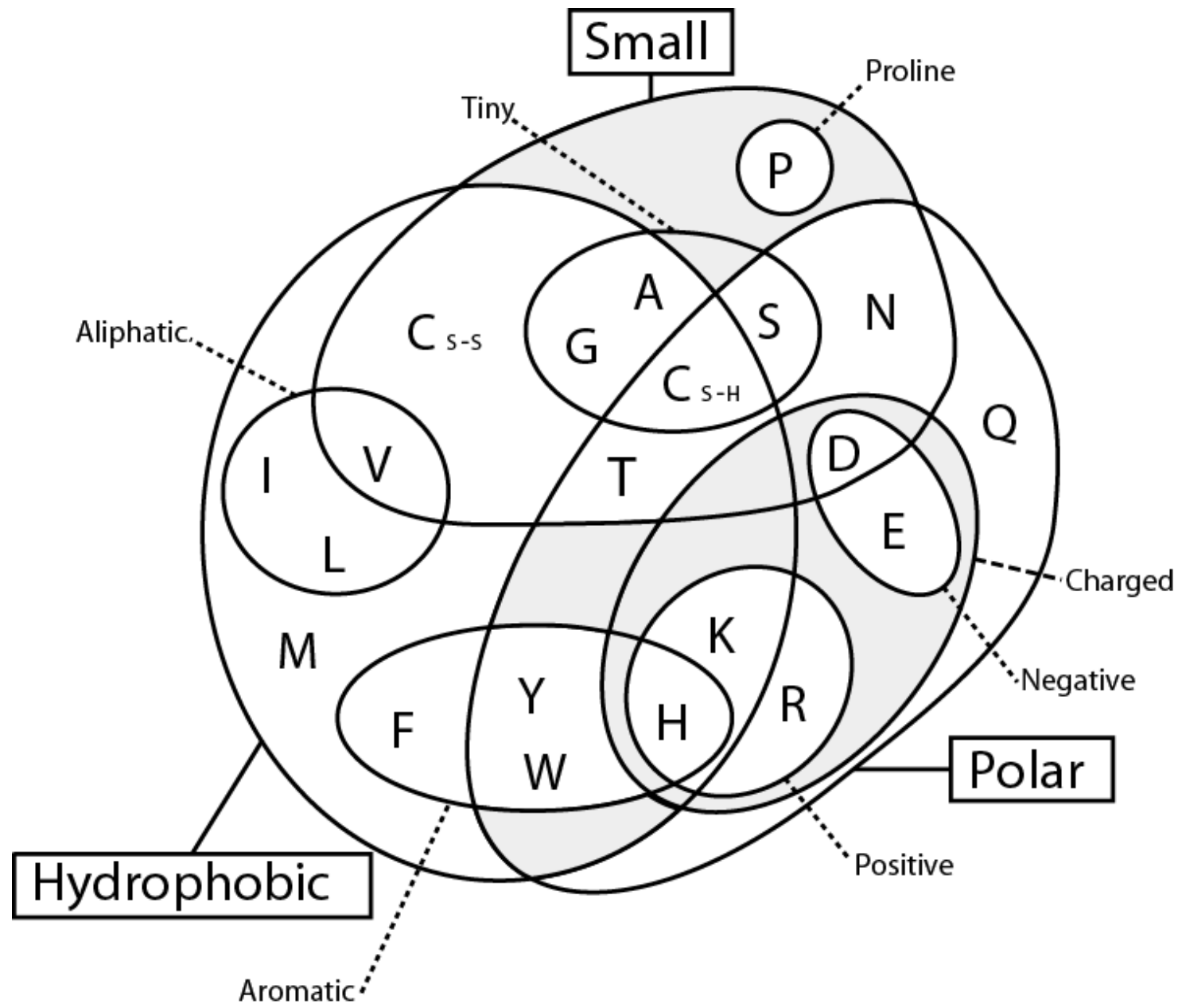


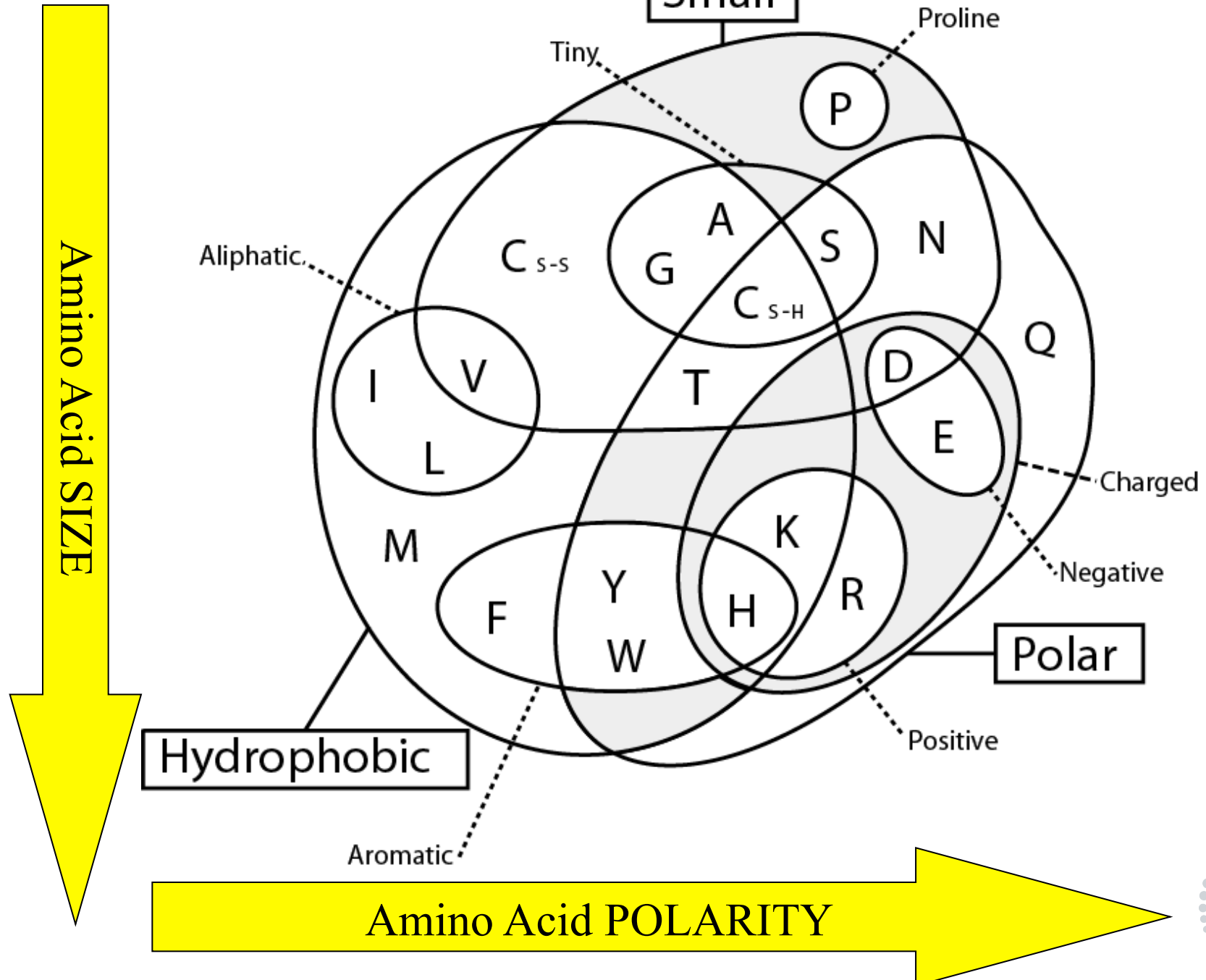
**G** Gly, Glycine

Glycine has no sidechain

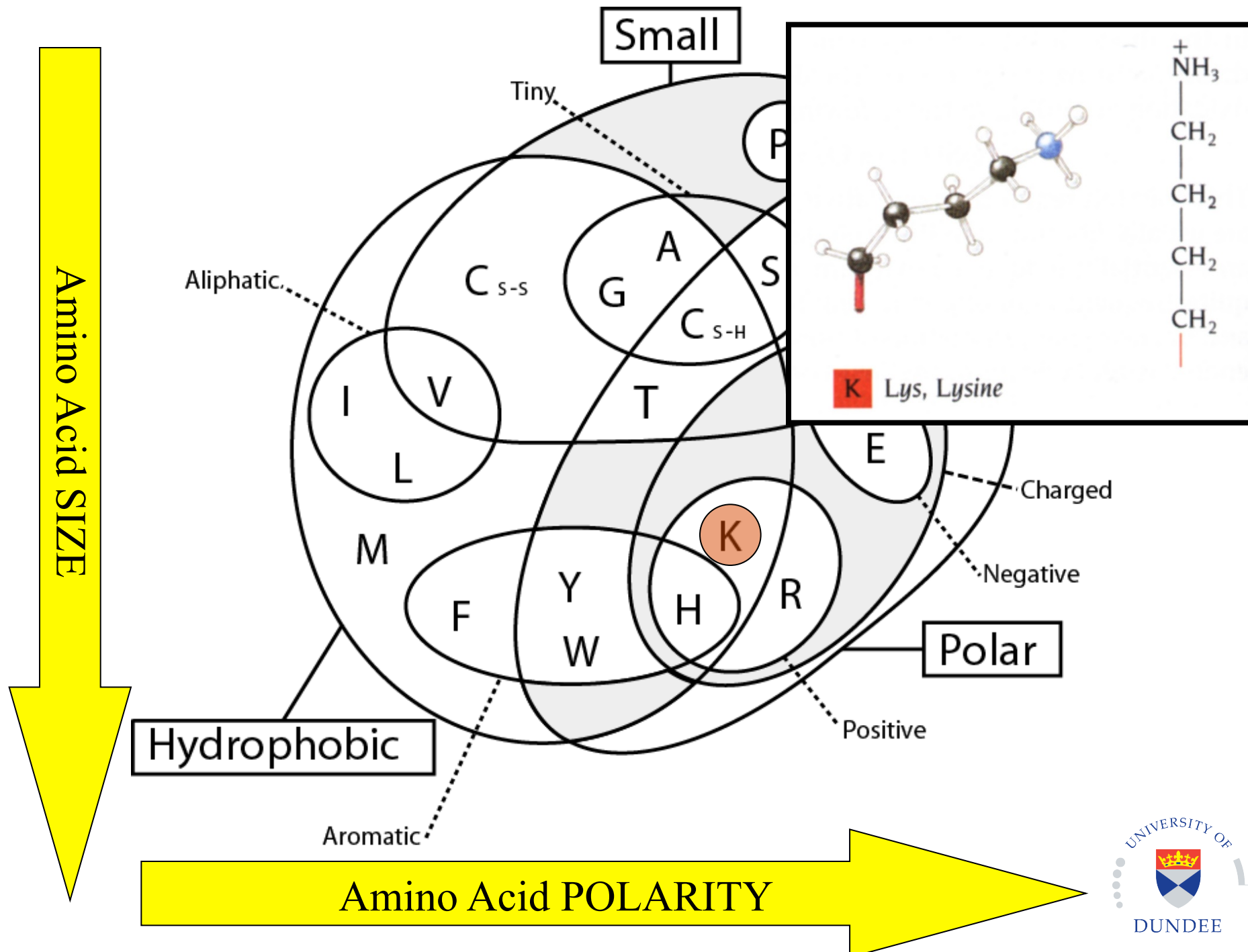
# Classification of properties is simplistic

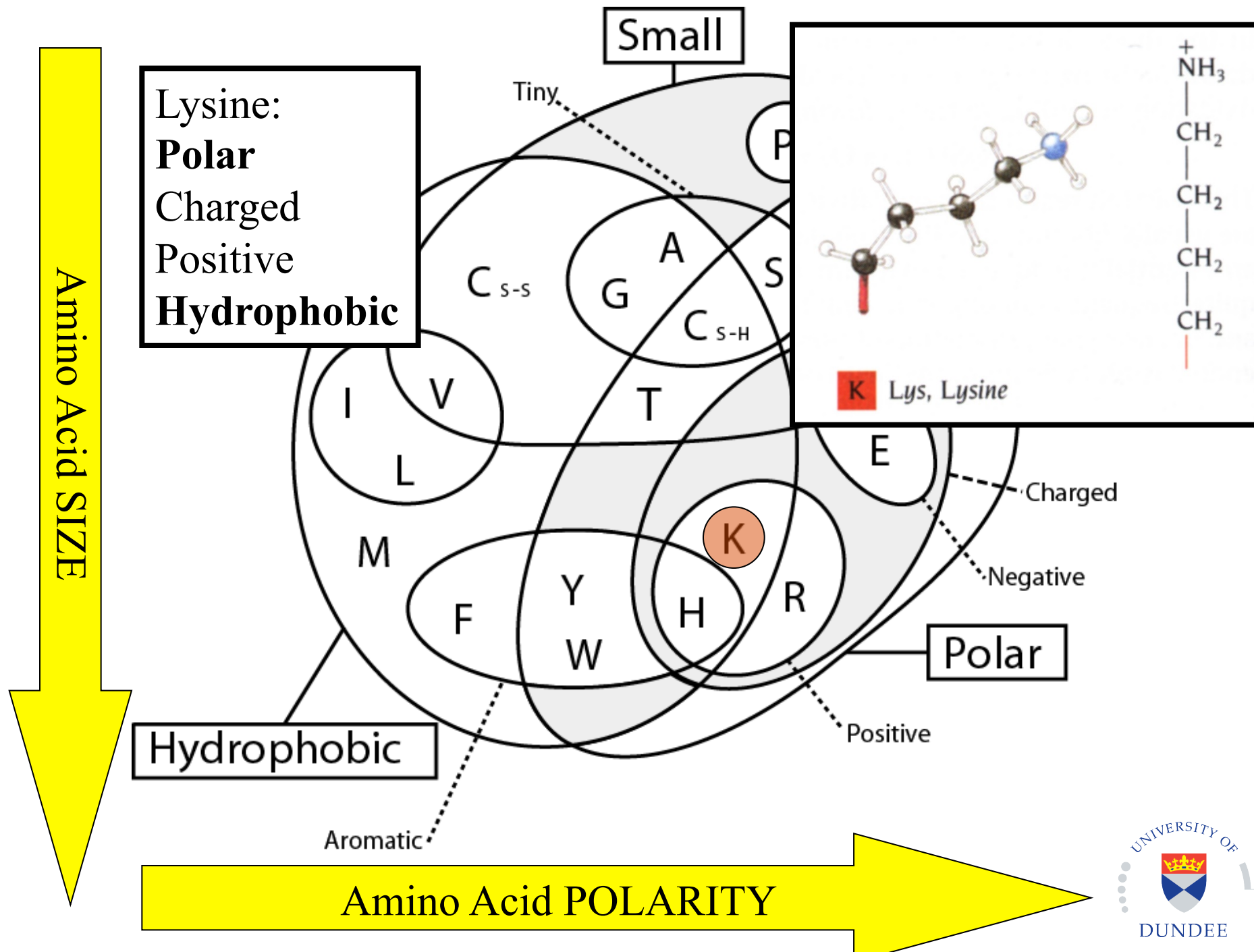
- Amino acids actually exhibit multiple properties
- This is better represented as a Venn diagram



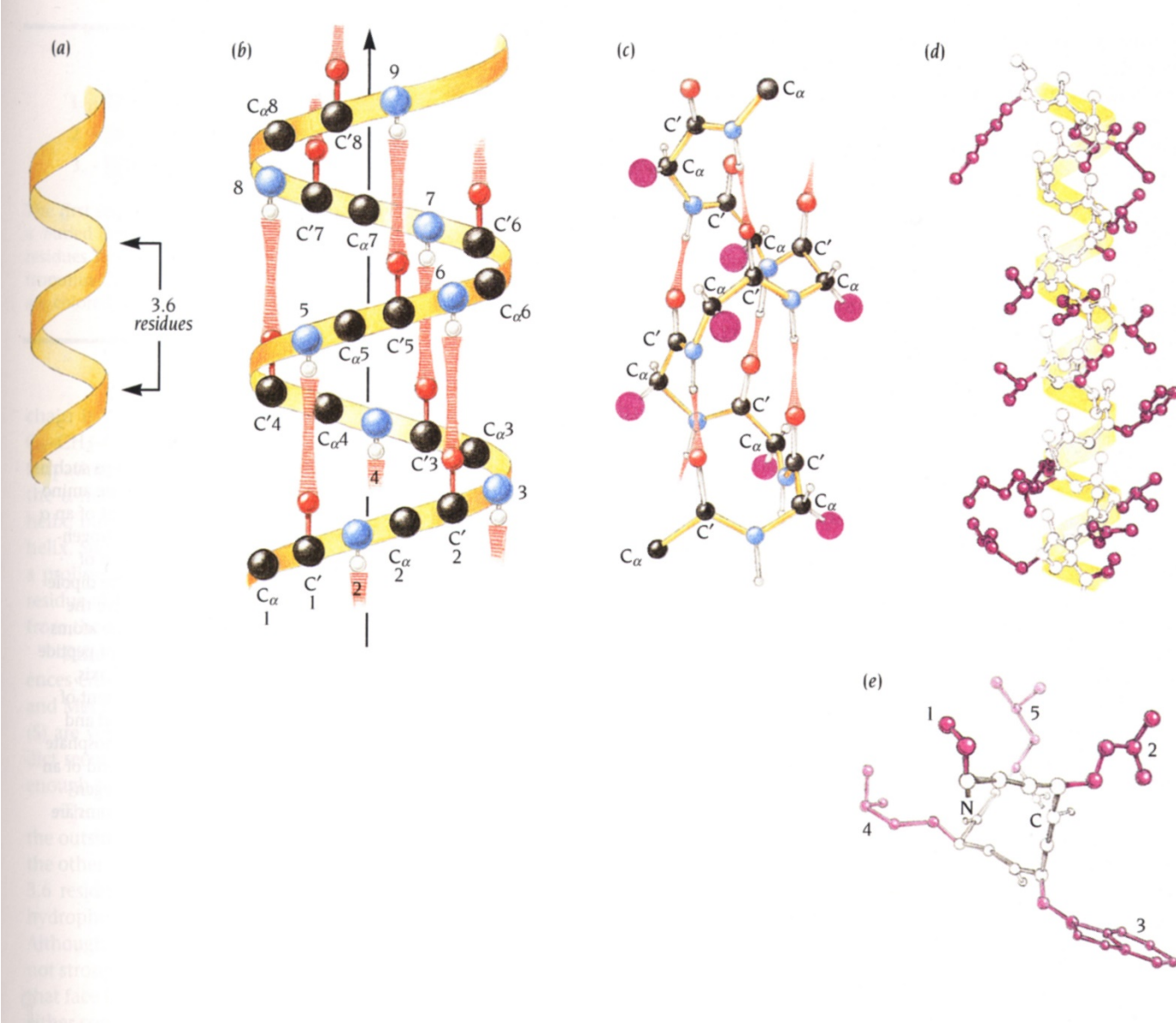








# Seondary Structure



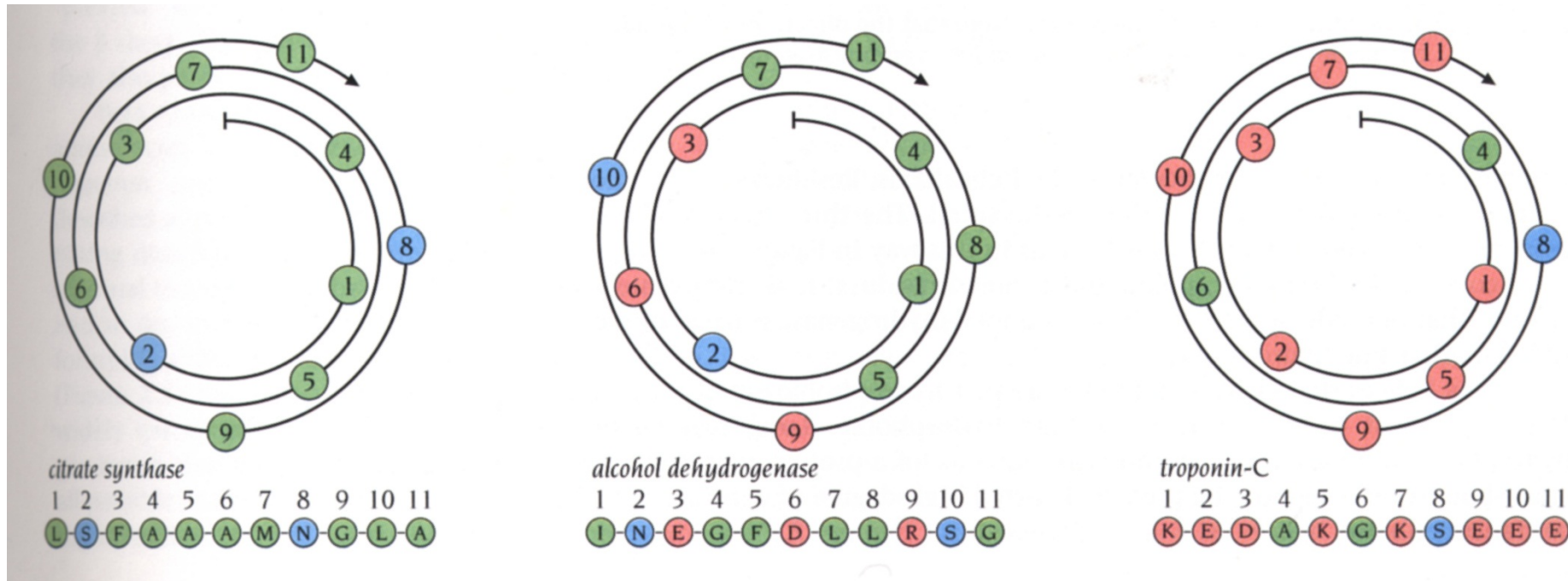
$\alpha$ -helix

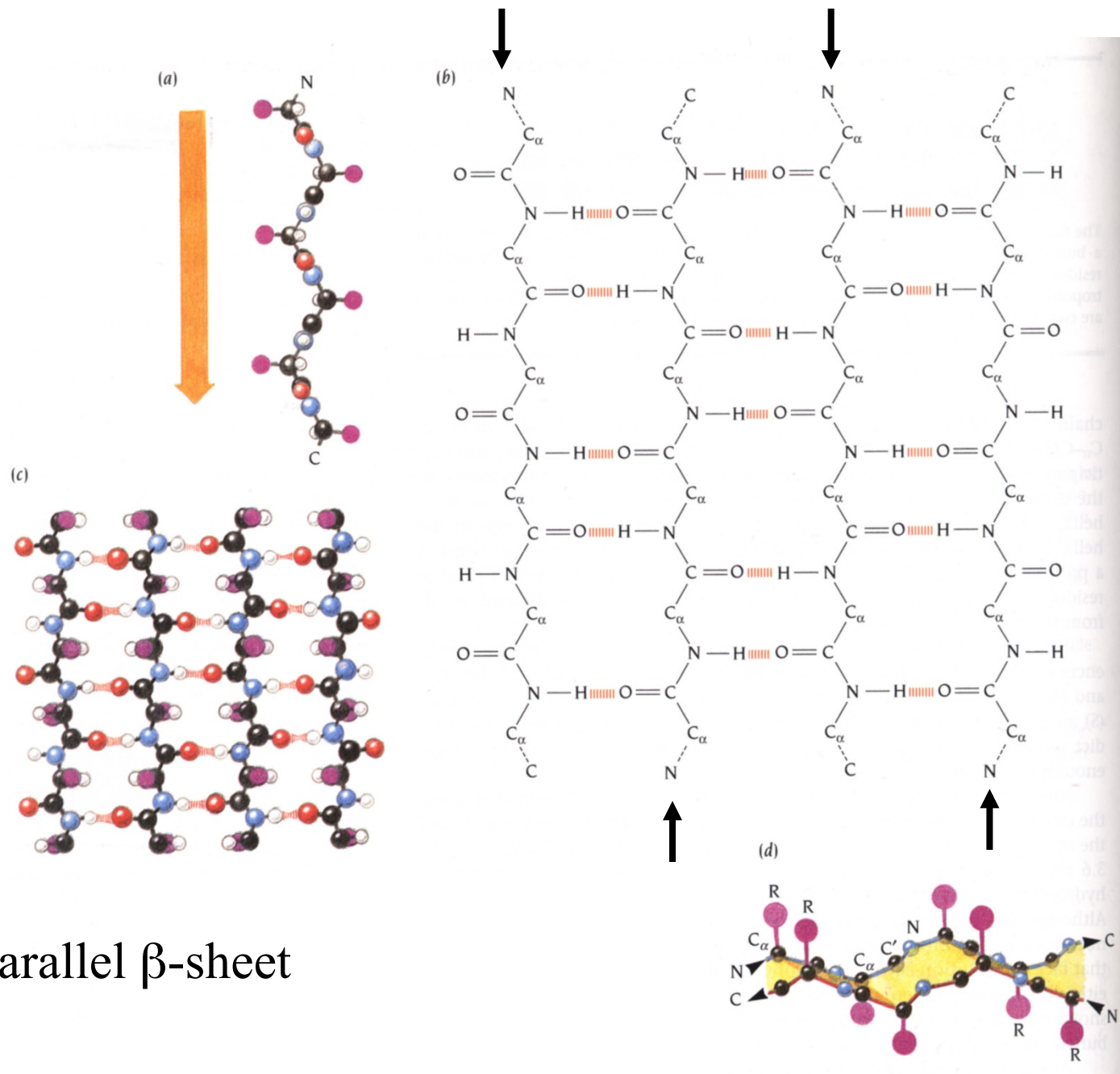
H-bonds stabilise helix structure  
 Other helix structures also occur with different  
 pitch.

1. - Leu - Ser - Phe - Ala - Ala - Ala - Met - Asn - Gly - Leu - Ala -  
 2. - Ile - Asn - Glu - Gly - Phe - Asp - Leu - Leu - Arg - Ser - Gly -  
 3. - Lys - Glu - Asp - Ala - Lys - Gly - Lys - Ser - Glu - Glu - Glu -

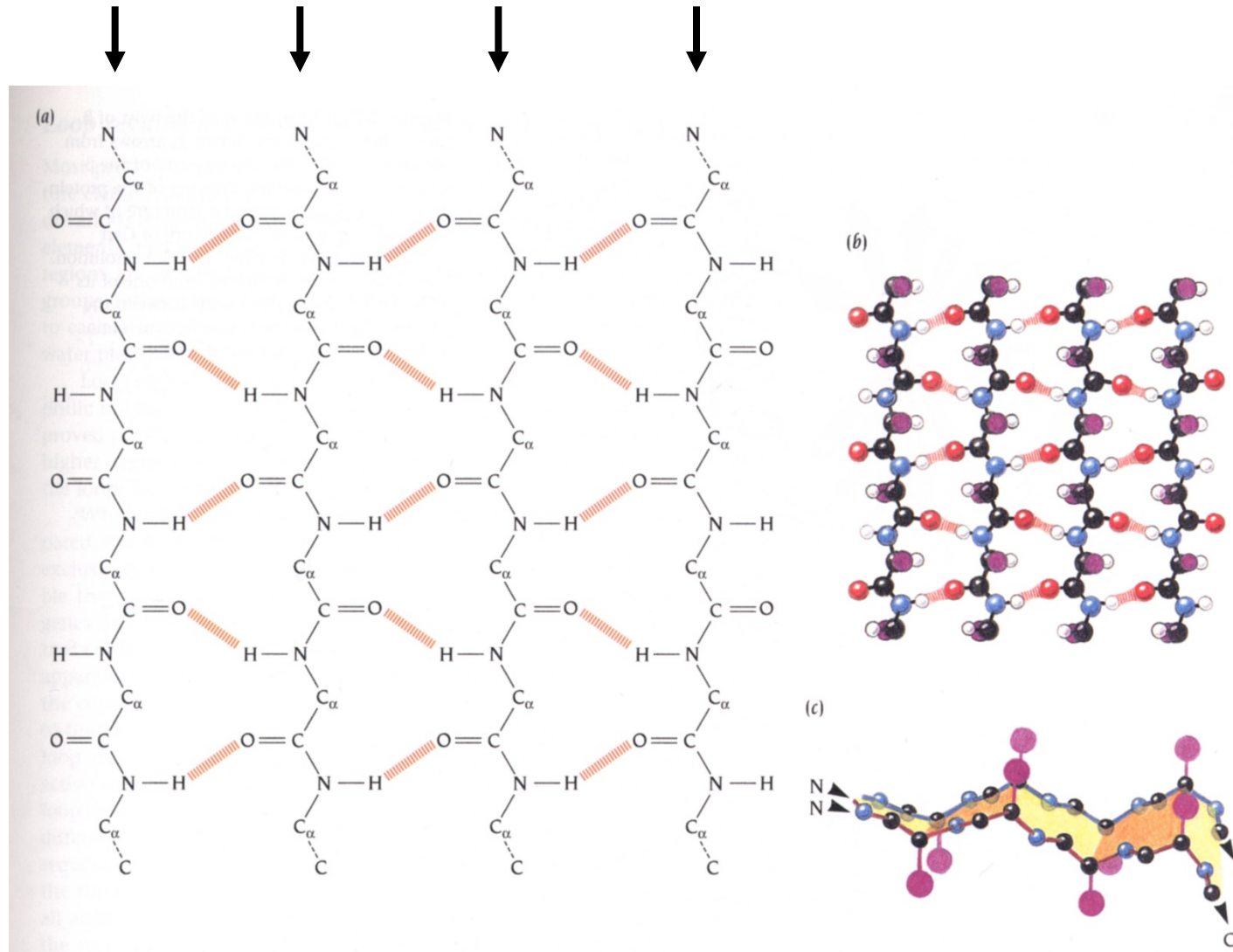
1. Buried helix; 2. part exposed helix; 3. exposed helix

Helical wheel plots to show location of hydrophobic amino acids on face of helix.



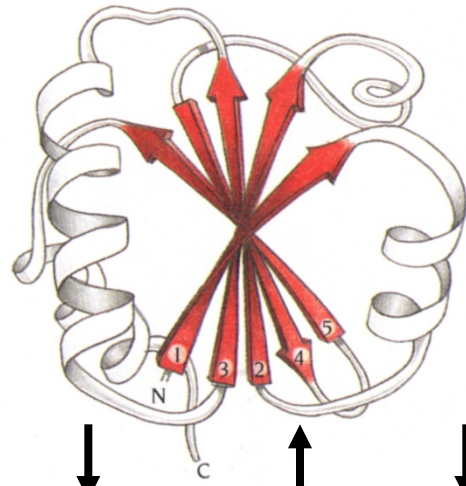


Antiparallel  $\beta$ -sheet

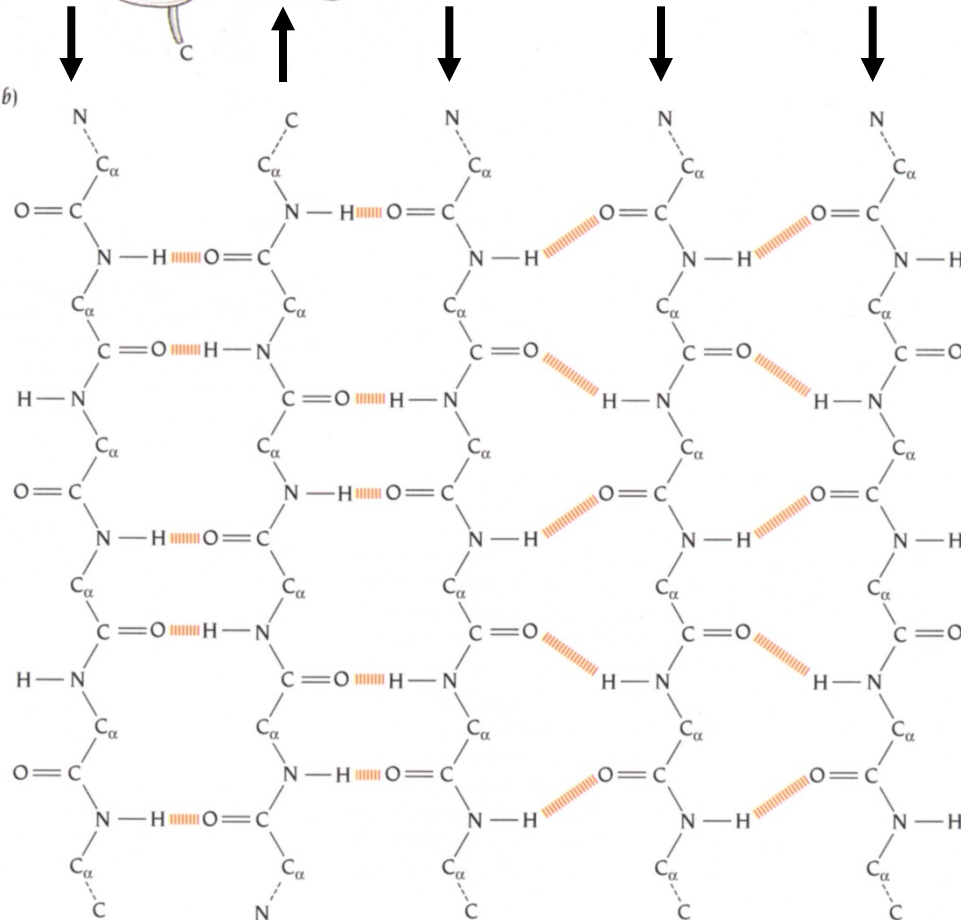


parallel  $\beta$ -sheet

(a)



(b)

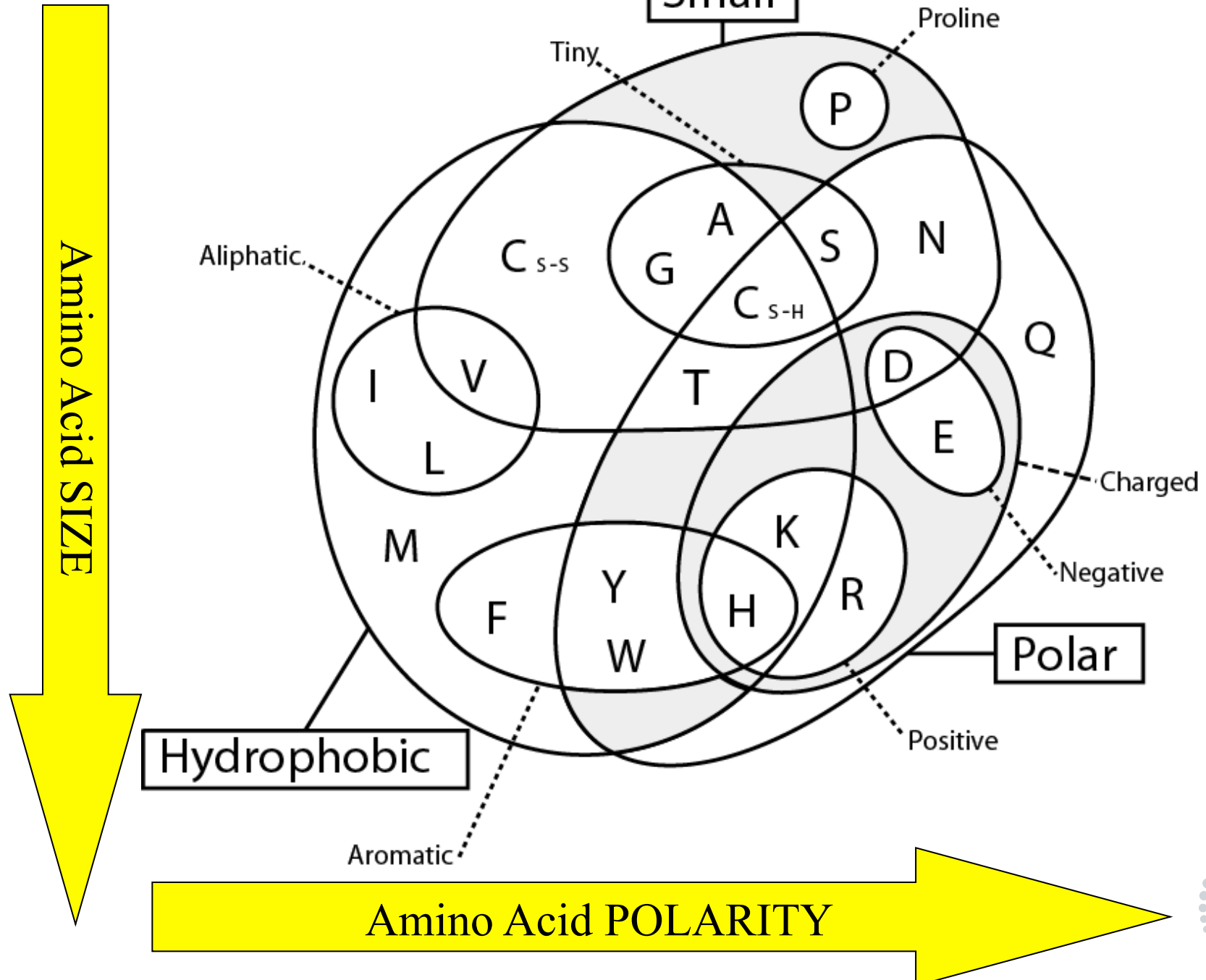


Thioredoxin – protein with mixed sheet.



# Glycine and Proline

Amino acids with special effects on protein three-dimensional structure



# Glycine

- Special properties
- “tiny” due to lack of sidechain
- Can occupy more of the Ramachandran plot due to lack of steric clashes from side-chain.
- Has special role in tight turns in protein structure

# Proline

- Proline – strictly is not an amino acid due to cyclic structure.
- Cannot form main-chain hydrogen bonds.
- Has only one rotatable mainchain bond.
- Tends to disrupt a helix
- Forms “bulge” in beta sheet