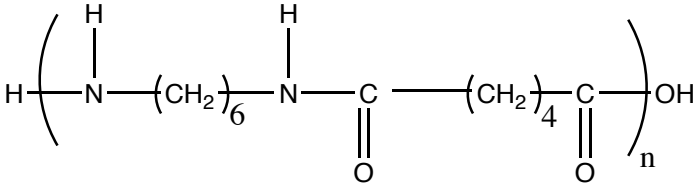
081001 Quiz 1 Morpholgy of Complex Materials

1) Proteins are the seminal model for molecular hierarchy. The primary structure is a sequence of amino acids.
   a) Give the generic chemical structure for an amino acid and a protein molecule (a tripeptide).
   b) Label the α-carbon, the β-carbon and the N and C termini of the protein.
   c) Show what parts of the structure are coplanar (sheet-like).
   d) Indicate the two bond angles used to make a Ramachandran plot giving the Greek letter for the angles and an English spelling of the letter, e.g. π and pi.
   e) What values of these angles are forbidden? Why?

2) Nylon displays some similarity and some differences with proteins. The following is the structure of Nylon 6,6:

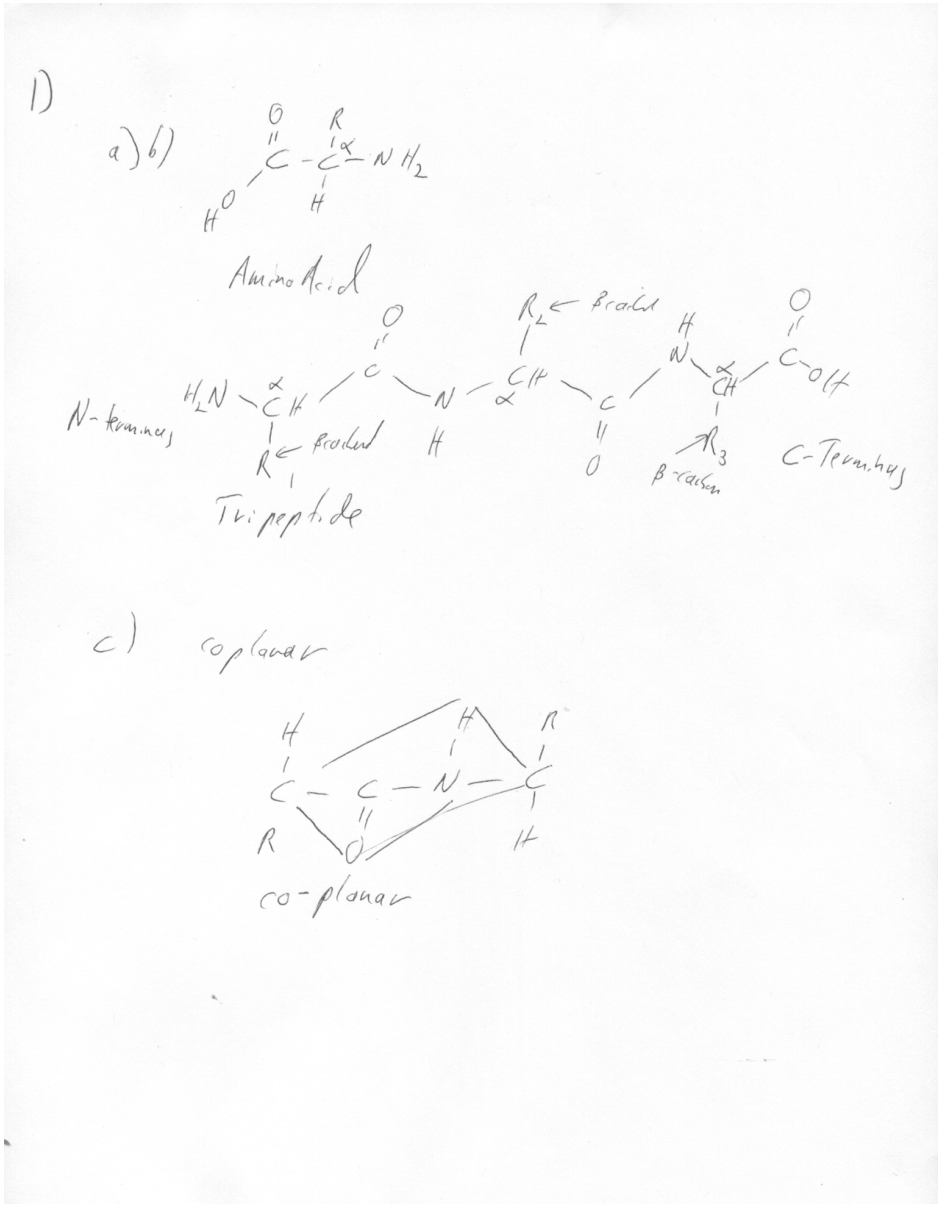


   a) Show what part of nylon is a rigid structure and compare this with a protein.
   b) Compare the flexibility of a protein to the flexibility of nylon.
   c) Show what part of nylon is a hydrogen bond acceptor and what part is a hydrogen bond donor. How does this compare with polypeptides?
   d) Does nylon have an N and a C terminus like a protein?
   e) Would you expect nylon to form a globular tertiary structure? Explain why (and describe the structure) or why not (and how nylon differs from a globular protein).

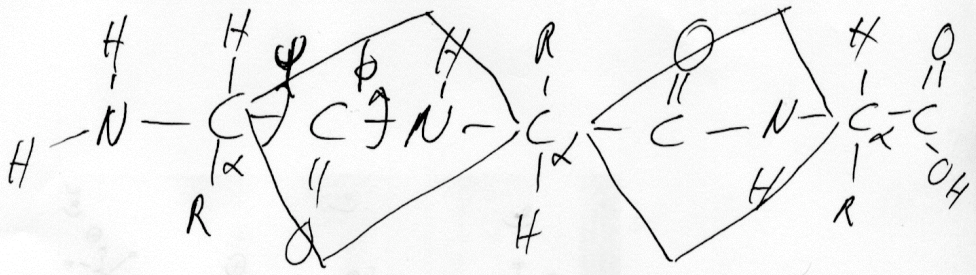
3) Amino acids are the mer units of a protein.
   a) Cystine (Cys C) is an important amino acid. Sketch the structure of cystine and explain the importance of cystine in protein structure.
   b) Proline (Pro P) is an important amino acid. Sketch the structure of proline and explain the importance of proline to protein structure.
   c) Give the structure of glycine (Gly G) and explain where glycine units might occur in the secondary structure of a protein.
   d) Give the structure of alanine (Ala A) and explain where alanine residues might occur in the secondary structure of a protein.
   e) Give the structure of methionine (Met M) and explain the special place it holds in the structure of proteins.

Answers: **081001 Quiz 1 Morpholgy of Complex Materials**

1)

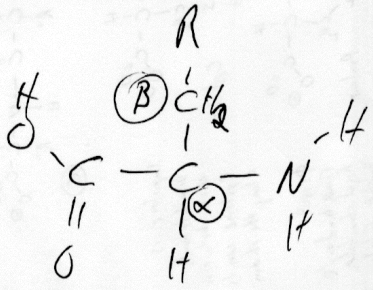


2)



N-terminus

C-terminus

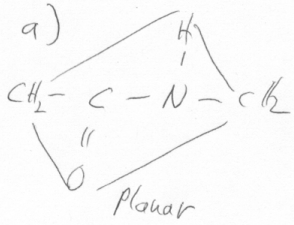


$\phi = \psi = 0^\circ$ is forbidden

and $\phi = 0$ or $\psi = 0$ due to steric constraints

2)

2) a)



Planar

this is the same planar unit as in proteins

b) Nylon is more flexible because the extended alkane chains have free rotation about the C–C bonds.

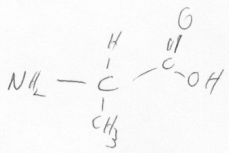
c) $-\overset{\overset{O}{\|}}{C}-$ acceptor $-\overset{\overset{H}{|}}{N}-$ donor

d) Yes, Nylon has an N & C–terminus.

e) No, Nylon does not form tertiary structure because it does not have functional side groups that can have specific interactions with other side groups in the chain.

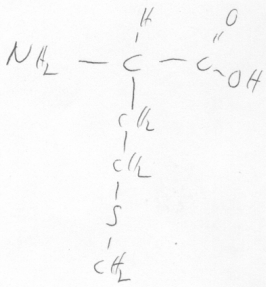
3)

d) alanine

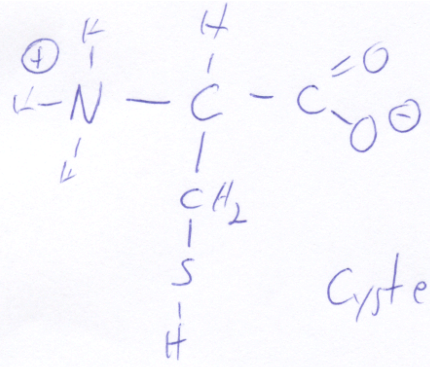


Flexible residue like glycine (folds & turns)
Hydrophobic

e) methionine

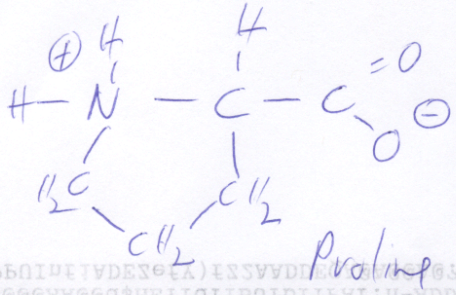


Nonpolar
Hydrophobic



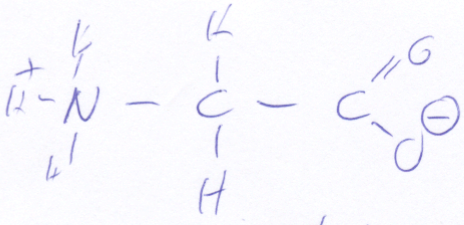
Cysteine

Important is Disulfide bonds occur between Cysteine units along the chain



Proline

$\phi = 180^\circ$
Fixed bond angle
Rigid structure
Breaks α-helix



Glycine

Occurs where flexibility is needed such as in helix or in a turn.