The stabilization is only possible if the planes defined by the sp^2 bonding units of the carbonyl C and N atoms are coplanar as shown.

If the two bonding units are not coplanar, the $2p_z$ orbitals of the O, C and N atoms would not all overlap as shown for the hybrid.

This means that rotation about the peptide bond is restricted.

As a result of the lack of free rotation, *cis* and *trans* peptide bonds are possible as follows:

The peptide bond in proteins is in the *trans* form. This form is more stable because there is less steric interaction between R groups of adjacent a.a..

Fig 6-4 shows a representation of a polypeptide chain with planar peptide groups.

Fig 6-4 also indicates that only the single bonds to the α- carbon atoms in the polypeptide backbone are free to rotate.

Thus it is rotation about these bonds which gives rise to the conformations of proteins.

Angles of rotation about the C_α-C and C_α-N bonds are referred to by the letters Ψ (psi) and Φ (phi) respectively as shown in the handout figure.

Ψ = 180° when adjacent peptide planes are coplanar with N_1 and N_2 *trans* to the C_α-C bond.

Φ = 180° when adjacent peptide planes are coplanar with carbonyl C_1 and C_2 *trans* to the N-C_α bond.

The handout figure shows an amino acid with Ψ and Φ angles of 180°.

Let's also define positive and negative angles of rotation.

While looking along a bond from one atom to another, a clockwise rotation of the farthest atom corresponds to a positive rotation.

Rotation of carbonyl C_2 (farthest atom) about the C_α in the direction shown in the figure corresponds to a positive rotation.

Rotation of N_1 (farthest atom) about the C_α in the direction shown in the figure corresponds to a positive rotation.

If the Φ and Ψ angles are constant throughout a polypeptide chain, the polypeptide will have the shape of a helix.

A given set of Φ and Ψ angles will determine the type of helix, i.e., n, the number a.a. per turn, p, the pitch, and d, the distance traversed by one a.a. along the helix axis.

The handout figure defines n, p and d.

The same n can result from other angles of Φ and Ψ as shown below

For a given value of Φ and different values of Ψ, helices of different n will result as represented below

Not all values of Φ and Ψ are equally favorable because of steric interactions within the polypeptide chain.

When $\Phi = 0°$ and $\Psi = 180°$, there is a large steric interaction between adjacent carbonyl O atoms as shown in the handout figure.