CHAPTER 10

Conclusion
As mentioned in the first chapter, eight significant molecules have been picked up with the effect of substitution of specific moieties in pyrrole and pyrrolo-pyrimidine at R1 in pyrrole derivatives and at R1, R2, R3 and R4 respectively including halogens at different positions.

The various pyrrole and pyrrolo-pyrimidine with halogen substituent systems which have been studied by X-ray diffraction technique and reported in the thesis can be broadly categorized into the following groups.

Group I

![Chemical structure diagram]

i. R1 = methoxy-phenyl  
   (Chapter 3 Part I)

ii. R1 = Bromo-phenyl  
    (Chapter 3 Part II)

Group II

<table>
<thead>
<tr>
<th>Structure</th>
<th>Chapter no./Code</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>R1=Phenyl</td>
<td>R2=Pyrrolidine</td>
<td>R3=Chloro Phenyl</td>
<td>--</td>
</tr>
<tr>
<td>4 A7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 D12</td>
<td></td>
<td>R1=Chloro-Phenyl</td>
<td>R2=Pyrrolidine</td>
<td>R3=Fluoro Phenyl</td>
<td>--</td>
</tr>
<tr>
<td>6 D14</td>
<td></td>
<td>R1=Chloro-Phenyl</td>
<td>R2=Phenyl Ethyl Amine</td>
<td>R3=Chloro Fluoro Phenyl</td>
<td>--</td>
</tr>
<tr>
<td>7 HX6</td>
<td></td>
<td>R1=Phenyl</td>
<td>R2=Phenyl</td>
<td>R3=Fluoro Phenyl</td>
<td>--</td>
</tr>
<tr>
<td>8 D6</td>
<td></td>
<td>R1=Chloro-Phenyl</td>
<td>R2=Pyrrolidine</td>
<td>R3=Fluoro Phenyl</td>
<td>--</td>
</tr>
<tr>
<td>9 HX3</td>
<td></td>
<td>R1=Phenyl</td>
<td>R2=NH2</td>
<td>R3=Methoxy Phenyl</td>
<td>R4=Phenyl</td>
</tr>
</tbody>
</table>
In the category of group I, a precise comparative analysis of some general features of few significant derivative of halogen (I, F, OCH3, and Br(present study)) have been carried out and presented. Table 10.1a and Table 10.1b show comparative list of bond lengths and bond angles of the halogen derivatives (Iodo, Fluoro and Bromo (present study)) of various compound. Molecular dimension of five membered pyrrole and the heterocycle in all four derivatives are normal.

As read from the torsional angles, (Table 10.1c), Carbonyl oxygen adopts a ‘CIS’ conformation whereas an ethoxy carbon adopts a ‘Trans’ conformation in all these derivatives. The precise comparative analysis of some general features like physical state, density, space group of crystallization, the R index, the dihedral angles between least-square planes and intermolecular interactions have been compared. It reveals that the molecule with different derivatives prefer to stay in monoclinic system and orthorhombic system.
Table 10.1a

Comparison of Bond Distances (Å)

<table>
<thead>
<tr>
<th></th>
<th>Average C - N in Pyrrole ring</th>
<th>C2 - O7</th>
<th>C5 - N6</th>
<th>N1 - C8</th>
<th>C15 - O19 (Carbonyl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E₂</td>
<td>1.4(3)</td>
<td>1.222(3)</td>
<td>1.348(4)</td>
<td>1.442(3)</td>
<td>1.222(4)</td>
</tr>
<tr>
<td>*E₃</td>
<td>1.398(2)</td>
<td>1.224(5)</td>
<td>1.344(6)</td>
<td>1.432(6)</td>
<td>1.208(6)</td>
</tr>
<tr>
<td>Present study</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E₄</td>
<td>1.404(4)</td>
<td>1.208(9)</td>
<td>1.333(10)</td>
<td>1.430(10)</td>
<td>1.211(10)</td>
</tr>
<tr>
<td>*D₃</td>
<td>1.394(3)</td>
<td>1.212(3)</td>
<td>1.331(3)</td>
<td>1.433(3)</td>
<td>1.218(3)</td>
</tr>
<tr>
<td>Present study</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10.1b

Comparison of Bond Angles (˚)

<table>
<thead>
<tr>
<th></th>
<th>Average C-C-C in Phenyl ring</th>
<th>C2-N1-C5</th>
<th>C4-C15-O16</th>
<th>C15-O16-C17</th>
<th>N1-C3-C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>E₂</td>
<td>119.82</td>
<td>110.4(2)</td>
<td>112.1(3)</td>
<td>117.0(3)</td>
<td>110.6(2)</td>
</tr>
<tr>
<td>*E₃</td>
<td>119.98</td>
<td>108.8(4)</td>
<td>111.0(4)</td>
<td>117.3(4)</td>
<td>110.4(4)</td>
</tr>
<tr>
<td>Present study</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E₄</td>
<td>119.96</td>
<td>110.4(6)</td>
<td>111.3(7)</td>
<td>117.0(7)</td>
<td>109.7(6)</td>
</tr>
<tr>
<td>*D₃</td>
<td>120.12</td>
<td>109.49(17)</td>
<td>112.7(2)</td>
<td>116.4(2)</td>
<td>111.10(19)</td>
</tr>
<tr>
<td>Present study</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Table 10.1c

Comparison of Few Selected Torsional Angles (˚)

<table>
<thead>
<tr>
<th></th>
<th>( E_2 )</th>
<th>( *E_3 ) Present study</th>
<th>( E_4 )</th>
<th>( *D_3 ) Present study</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2 - N1 - C8 - C9</td>
<td>-112.1(3)</td>
<td>-122.0(4)</td>
<td>120.0(8)</td>
<td>124.2(3)</td>
</tr>
<tr>
<td>C2 - N1 - C8 - C13</td>
<td>67.0(4)</td>
<td>55.7(5)</td>
<td>-55.8(10)</td>
<td>-54.7(3)</td>
</tr>
<tr>
<td>C5 - N1 - C8 - C9</td>
<td>69.2(4)</td>
<td>45.3(6)</td>
<td>-48.9(10)</td>
<td>-63.0(3)</td>
</tr>
<tr>
<td>C5 - N1 - C8 - C13</td>
<td>-111.7(3)</td>
<td>-137.1(4)</td>
<td>135.4(8)</td>
<td>118.2(3)</td>
</tr>
<tr>
<td>C3 - C4 - C15 - O16</td>
<td>2.5(4)</td>
<td>5.7(6)</td>
<td>-2.8(11)</td>
<td>1.7(4)</td>
</tr>
<tr>
<td>C3 - C4 - C15 - O19</td>
<td>-177.3(3)</td>
<td>-176.5(4)</td>
<td>176.7(8)</td>
<td>-177.7(3)</td>
</tr>
<tr>
<td>C5 - C4 - C15 - O16</td>
<td>172.4(3)</td>
<td>-176.1(4)</td>
<td>176.4(7)</td>
<td>-178.3(2)</td>
</tr>
<tr>
<td>C5 - C4 - C15 - O19</td>
<td>-7.3(5)</td>
<td>1.7(7)</td>
<td>-4.1(13)</td>
<td>2.3(4)</td>
</tr>
<tr>
<td>C17 - O16 - C15 - C4</td>
<td>-174.9(3)</td>
<td>178.5(4)</td>
<td>-177.4(8)</td>
<td>-179.5(2)</td>
</tr>
<tr>
<td>C17 - O16 - C15 - O19</td>
<td>4.8(5)</td>
<td>0.5(7)</td>
<td>3.0(12)</td>
<td>-0.1(4)</td>
</tr>
<tr>
<td>C15 - O16 - C17 - C18</td>
<td>144.9(4)</td>
<td>177.4(4)</td>
<td>177.2(8)</td>
<td>-177.0(3)</td>
</tr>
</tbody>
</table>

\( E_2 \) = Fluoro derivative of 2-Amino-1-(4-fluoro-phenyl)-5-oxo-4,5-dihydro-1H-pyrrole-3-carboxylic acid ethyl ester Present study [164]

\( *E_3 \) = Bromo derivative of 2-Amino-1-(4-phenyl)-5-oxo-4,5-dihydro-1H-pyrrole-3-carboxylic acid ethyl ester

\( E_4 \) = Iodo derivative of 2-Amino-1-(4-phenyl)-5-oxo-4,5-dihydro-1H-pyrrole-3-carboxylic acid ethyl ester [165]

\( *D_3 \) = Methoxy derivative 2-Amino-1-(4-phenyl)-5-oxo-4,5-dihydro-1H-pyrrole-3-carboxylic acid ethyl ester
In the category of the group II, among six fused Pyrrolo-Pyrimidine derivatives (five derivatives contain halogen and one does not) by X-ray diffraction technique.

a. Pyrrolo-pyrimidine fused systems with substitutes at position $R_1$ of Pyrrole ring.

b. Pyrrolo-pyrimidine fused systems with substitutes at position $R_2$ of Pyrimidine ring.

c. Pyrrolo-pyrimidine fused systems with substitutes at position $R_3$ of Pyrrole at N1 Position.

d. Pyrrolo-pyrimidine fused systems with substitutes at position $R_4$ of Pyrimidine ring at meta position.

- Here we reported most of the structures having a, b and c type.
- Phenyl substituted derivatives are shown in Chapters 4, 7 and 9.
- Chloro-phenyl substituted derivatives are shown in Chapters 4, 5, 6 and 8.
- Methoxy-phenyl substituted derivatives are shown in Chapter 9.

Table 10.2a and 10.2b present the selected bond lengths, angles between different planar groups of various Pyrrolo-pyrimidine derivatives.

The observed interesting features of these groups of Pyrrolo-pyrimidine derivatives are:

- In this group of compounds, methoxy-phenyl derivatives are having two molecules per asymmetric unit as reported in Chapter 9, both the crystallographically independent molecular conformations, though only the size of the substituent is different. The endocyclic bond lengths C-N, C-C and the bond angles C – N – C, N – C – C vary drastically.

- In most of the structures $R_2$ substituted pyrrole ring is highly puckered.

- Halogens remains in active in interactions, only in chapter 9 part II the C-hal...π interaction can be seen.

- The nine membered pyrrolidine rings are almost planar.
### Table 10.2b
Comparison of Bond Distances (Å)

<table>
<thead>
<tr>
<th>Code</th>
<th>Average C - N in Pyrrole ring</th>
<th>Average C - N in Pyrimidine ring</th>
<th>Average C – hal. Distance</th>
<th>Average C - C in Phenyl ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7</td>
<td>1.403</td>
<td>1.335</td>
<td>1.759</td>
<td>1.376</td>
</tr>
<tr>
<td>D12</td>
<td>1.398</td>
<td>1.339</td>
<td>1.357</td>
<td>1.375</td>
</tr>
<tr>
<td>D14</td>
<td>1.398</td>
<td>1.341</td>
<td>1.556</td>
<td>1.376</td>
</tr>
<tr>
<td>Hx-6</td>
<td>1.392</td>
<td>1.335</td>
<td>1.360</td>
<td>1.372</td>
</tr>
<tr>
<td>D6</td>
<td>1.396</td>
<td>1.337</td>
<td>1.361</td>
<td>1.376</td>
</tr>
<tr>
<td>HX-3</td>
<td>1.396</td>
<td>1.336</td>
<td>-</td>
<td>1.377</td>
</tr>
</tbody>
</table>

### Table 10.2a
Comparison of Bond Angles (°)

<table>
<thead>
<tr>
<th>Code</th>
<th>C2-N1-C9 in Pyrrole ring</th>
<th>N6-C7-N8 in Pyrimidine ring</th>
<th>N8-C9-C4 in Pyrimidine ring</th>
<th>Average C- C- C in Phenyl ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7</td>
<td>106.0(2)</td>
<td>130.3(3)</td>
<td>126.4(3)</td>
<td>120</td>
</tr>
<tr>
<td>D12</td>
<td>107.8(14)</td>
<td>129.41(18)</td>
<td>126.88(16)</td>
<td>120</td>
</tr>
<tr>
<td>D14</td>
<td>107.2(3)</td>
<td>129.6(4)</td>
<td>126.5(3)</td>
<td>120</td>
</tr>
<tr>
<td>Hx-6</td>
<td>106.75(16)</td>
<td>128.7(2)</td>
<td>126.60(18)</td>
<td>120</td>
</tr>
<tr>
<td>D6</td>
<td>107.49(16)</td>
<td>129.30(20)</td>
<td>127.01(19)</td>
<td>120</td>
</tr>
<tr>
<td>HX-3</td>
<td>107.6(2)</td>
<td>127.2(3)</td>
<td>127.2(3)</td>
<td>120</td>
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</tbody>
</table>