A monosubstituted benzene, when treated with an electrophile, could undergo three electrophilic aromatic substitution reactions. Each reaction yields a disubstituted benzene as the organic product, which can be identified using the descriptors ortho, meta, and para (see ortho carbon).

\[
\text{A} \quad + \quad \text{E}^+ \quad \rightarrow \quad \text{ortho product} \quad + \quad \text{A} \quad \quad + \quad \text{E}^+ \\
\text{A} \quad + \quad \text{E}^+ \quad \rightarrow \quad \text{meta product} \quad + \quad \text{A} \quad \quad + \quad \text{E}^+ \\
\text{A} \quad + \quad \text{E}^+ \quad \rightarrow \quad \text{para product} \quad + \quad \text{A} \quad \quad + \quad \text{E}^+
\]

\[A = \text{any substituent}\]
\[E^+ = \text{electrophile}\]

If the relative yield of the ortho product and that of the para product are higher than that of the meta product, the substituent on the benzene ring in the monosubstituted benzene is called an ortho, para directing group. If the opposite is observed, the substituent is called a meta directing group.

\text{eg. 1:}
Thus, the methyl group is an ortho, para directing group.

eg. 2:
Thus, the nitro group is a meta directing group.

Ortho, para directing groups are electron-donating groups; meta directing groups are electron-withdrawing groups. The halide ions, which are electron-withdrawing but ortho, para directing, are the exception.

Common ortho, para directing groups:

- $\text{OR}$ \quad (R = H, alkyl, aryl, acyl)
- $\text{NR}_2$ \quad (R = H, alkyl, aryl, acyl, or any combination thereof)
- $\text{R}$ \quad (R = alkyl, aryl)
- $\text{X}$ \quad (X = F, Cl, Br, I)

Common meta directing groups:
---NO₂

---NO

+ NR₃ (R = H, alkyl, aryl, or any combination thereof)

---C=R (R = H, alkyl, aryl, hydroxy, alkoxy, phenoxy, NH₂)

---CX₃ (X = F, Cl, Br, I)

---CN

---SO₂H

see also activating group, deactivating group

Contributors

- Gamini Gunawardena from the OChemPal site (Utah Valley University)