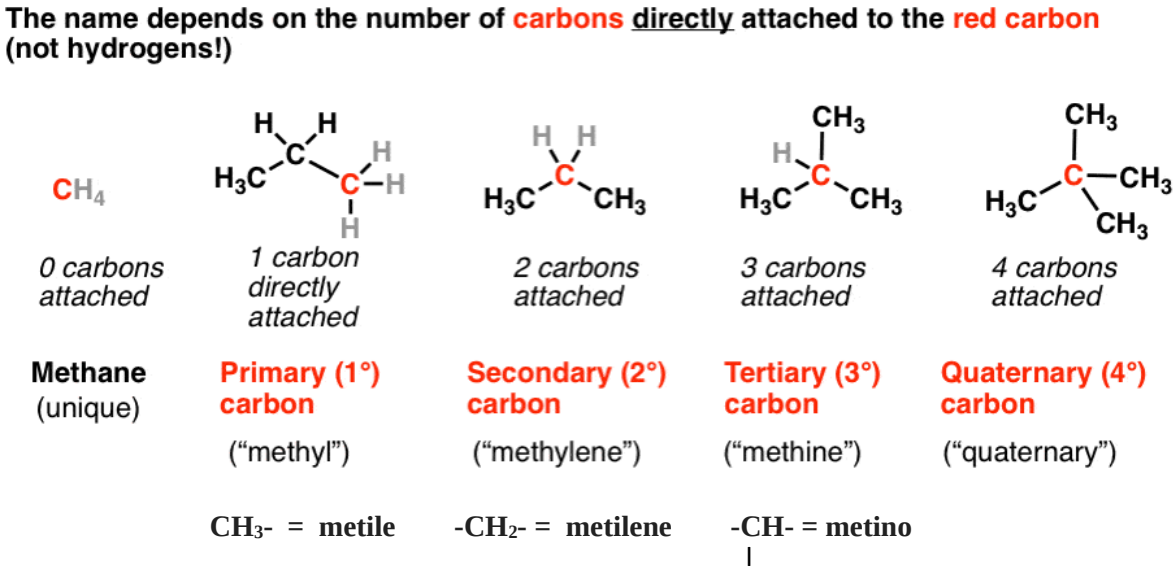
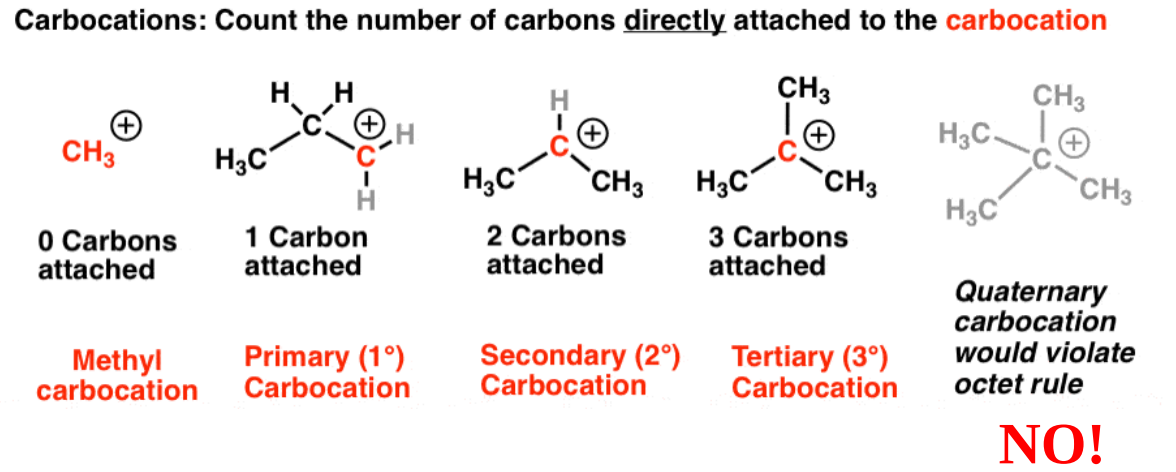
Primary, Secondary, Tertiary, Quaternary in Organic Chemistry

- **Primary carbons**, are carbons attached to *one* other carbon. (Hydrogens – although usually 3 in number in this case – are ignored in this terminology, as we shall see).
- **Secondary carbons** are attached to two other carbons.
- **Tertiary carbons** are attached to three other carbons.
- Finally, **quaternary carbons** are attached to *four* other carbons.

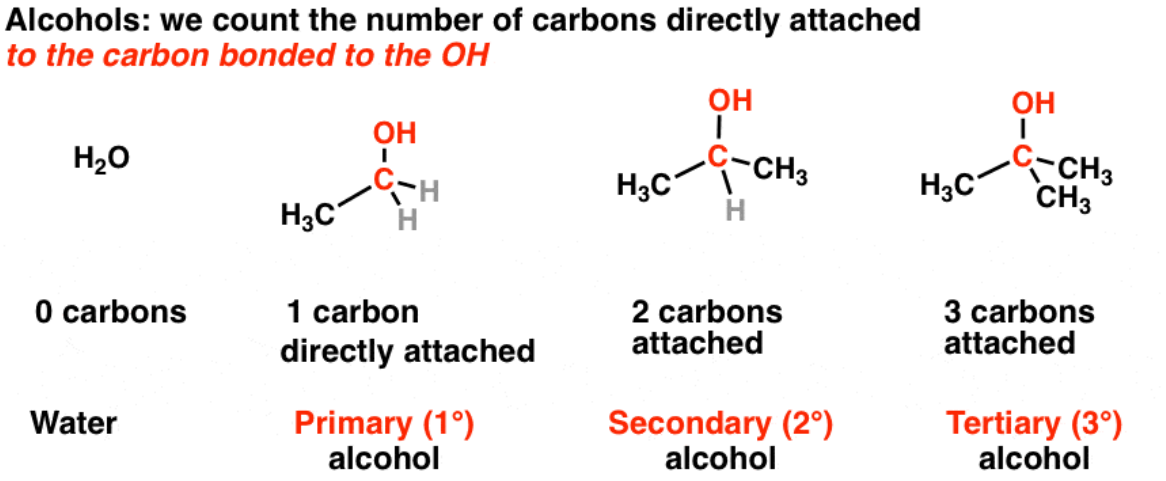
You can't go higher than that. To have five substitutents, you'd need 10 electrons around carbon, a clear violation of the octet rule.



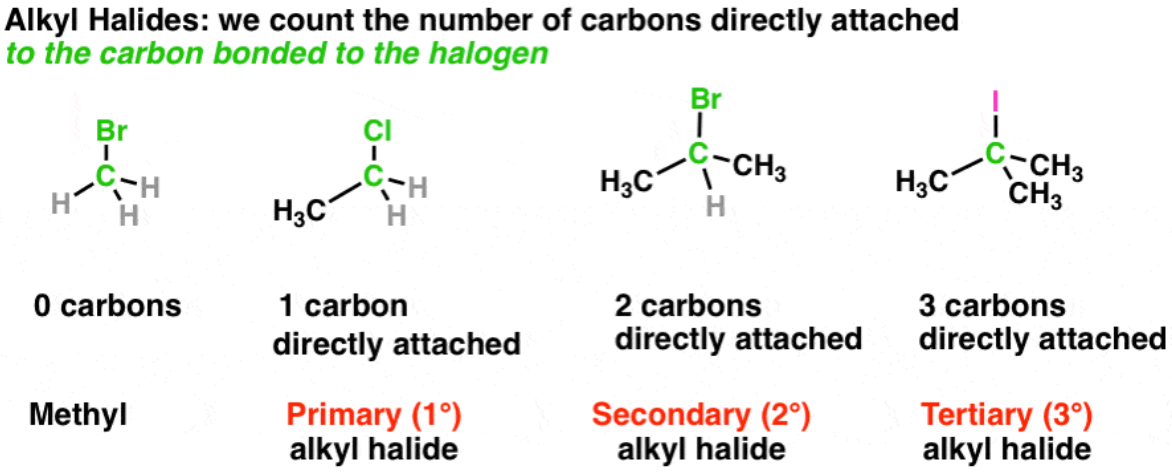
We use the same terminology for **carbocations**. A primary carbocation is attached to one other carbon, a secondary to two, and a tertiary to three. You can't have a quaternary carbocation without violating the octet rule either!



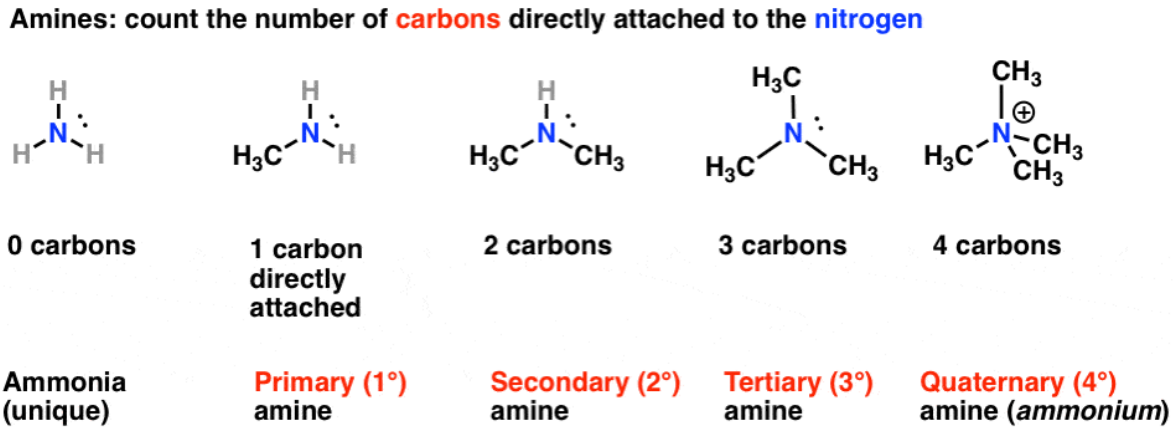
Alcohols also follow the **primary/secondary/tertiary** nomenclature. The rule for alcohols is that they are named according to the number of carbons attached to the carbon bearing the hydroxyl group: **in other words, whether the hydroxyl bound to a primary, secondary, or tertiary carbon**. You can't have a quaternary alcohol – again, that would involve breaking the octet rule. [A bit of non-essential nomenclature: the carbon attached to the OH is sometimes referred to as the "carbinol" carbon].



A related category of compounds are the **alkyl halides**. The naming for alkyl halides is similar to that for alcohols: they are named **according to the number of carbons attached to the halogen**, where halogen is fluorine, chlorine, bromine, or iodine.



Next, we come to **amines**, which are a little bit different. They are named according to the number of carbons attached to nitrogen. **Primary, secondary, and tertiary amines are nitrogens bound to one, two and three carbons, respectively**. Since the nitrogen has a lone pair, it is still possible to form another bond to carbon. These are called quaternary amines, although they bear a positive charge on nitrogen and are not at all basic. They are often referred to as quaternary ammonium salts. You'll see the -ium ending quite a bit – it designates a positively charged species.



Finally, **amides** also fall into this category. A **primary amide** is bound to one carbon – the carbonyl carbon. Successive substitutions of hydrogen for carbon turn the amide into **secondary** and **tertiary amides**.