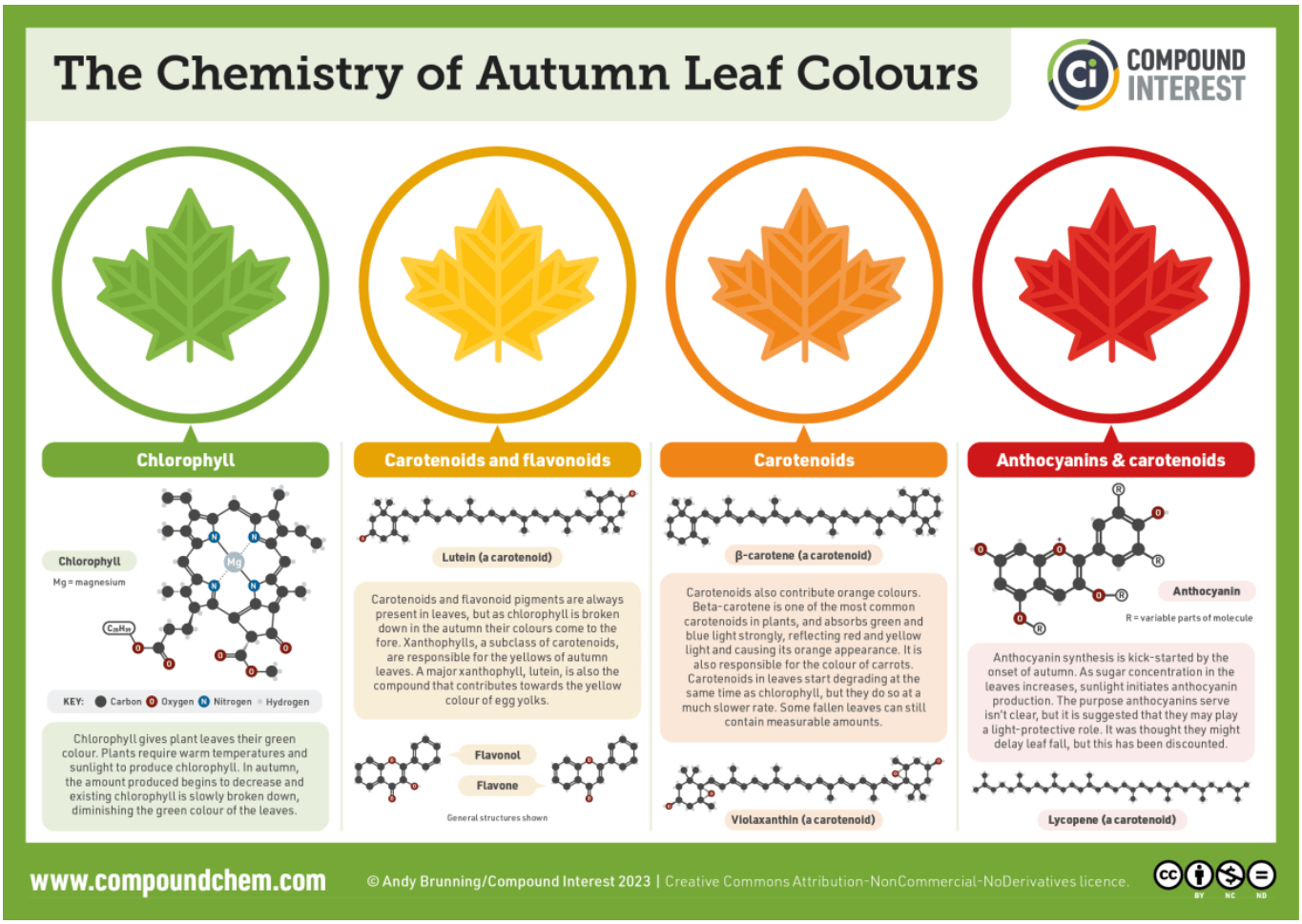

With autumn looming on the horizon, the leaves on some trees have already begun the transition towards the vibrant hues of autumn. Whilst this change may outwardly seem like a simple one, the many vivid colours are a result of a range of chemical compounds, a selection of which are detailed here.

Before discussing the different compounds that lead to the colours of autumn leaves, it's worth discussing how the colours of these compounds originate in the first place. To do this we need to examine the chemical bonds they contain – these can be either single bonds, which consist of one shared pair of electrons between adjacent atoms, or double bonds, which consist of two shared pairs of electrons between adjacent atoms. The colour-causing molecules in autumn leaves contain systems of alternating double and single bonds – this is referred to as conjugation. A large amount of conjugation in a molecule can lead to it being able to absorb wavelengths of light in the visible spectrum. This leads to the appearance of colour.

Chlorophyll

Chlorophyll is the chemical compound responsible for the usual, green colouration of most leaves. This chemical is contained within chloroplasts in the leaf cells. It is an essential component of the photosynthesis process via which plants use energy from the sun to convert carbon dioxide and water into sugars. For the production of chlorophyll, leaves require warm temperatures and sunlight – as summer begins to fade, so too does the amount of light, and thus chlorophyll production slows, and the existing chlorophyll decomposes. As a result, other compounds present in the leaves can come to the fore, affecting the perceived colouration.

Carotenoids & Flavonoids

Carotenoids and flavonoids are both large families of chemical compounds. These compounds are present in the leaves along with chlorophyll, but the high levels of chlorophyll present in the summer months usually mask their colours. As the chlorophyll degrades and disappears in autumn, their colours become more noticeable – both families of compounds contribute yellows, whilst carotenoids also contribute oranges and reds. These compounds do also degrade along with chlorophyll as autumn progresses but do so at a much slower rate than chlorophyll, and so their colours become visible. Notable carotenoids include beta-carotene, the cause of the orange colour of carrots, lutein, which contributes to the yellow colour of egg yolks, and lycopene, which is also responsible for the red colour of tomatoes.

Anthocyanins

Anthocyanins are also a member of the flavonoid class of compounds. Unlike carotenoids, anthocyanins aren’t commonly present in leaves year-round. As the days darken, their synthesis is initiated by increased concentration of sugars in the leaves, combined with sunlight. Their precise role in the leaf is still unclear – there has been some suggestion, however, that they may perform some kind of light-protective role, allowing the tree to protect its leaves from light damage and extend the time before they are shed. In terms of their contribution to the colour of autumn leaves, they provide vivid red, purple, and magenta shades. Their colour is also affected by the acidity of tree sap, producing a range of hues.