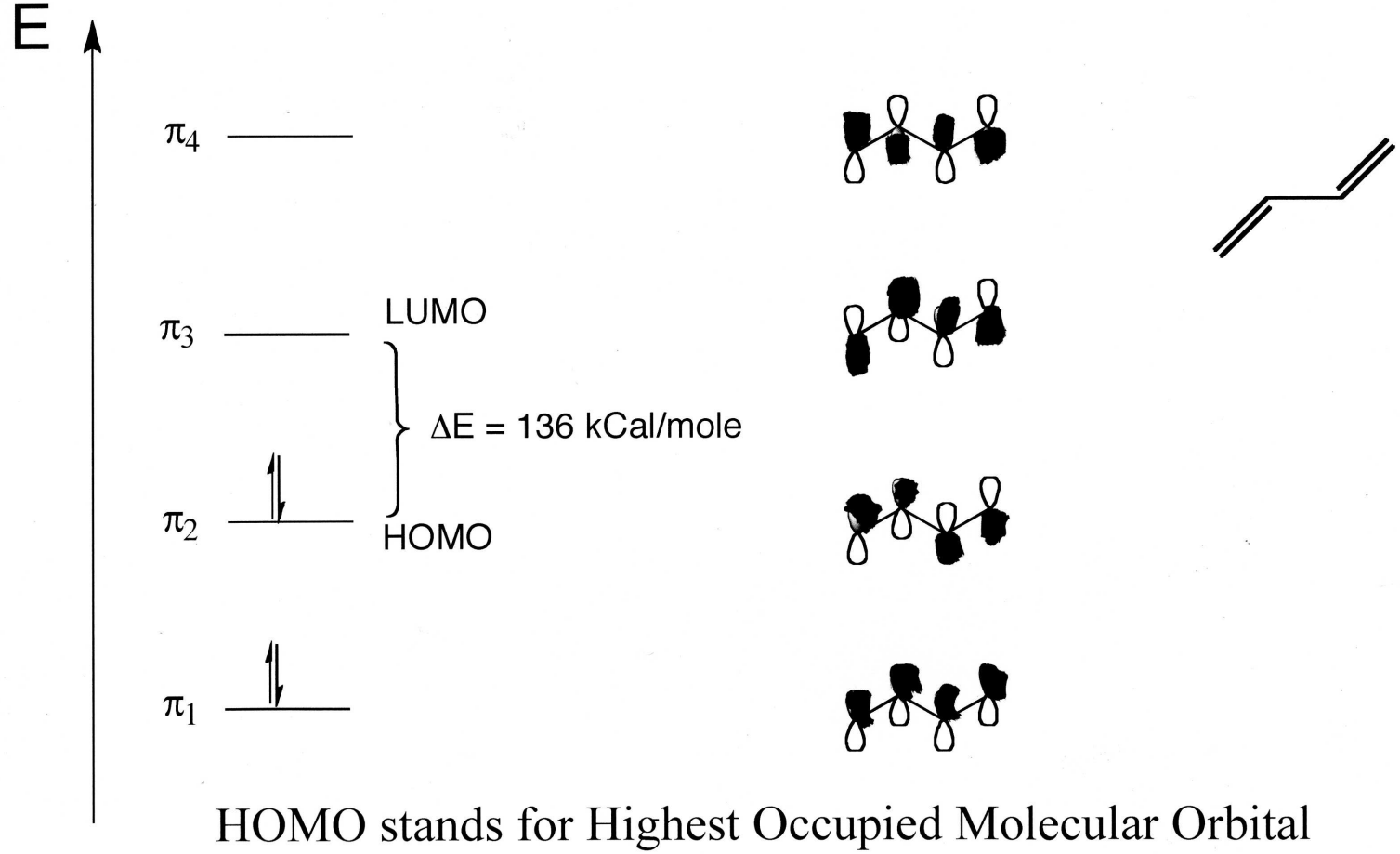
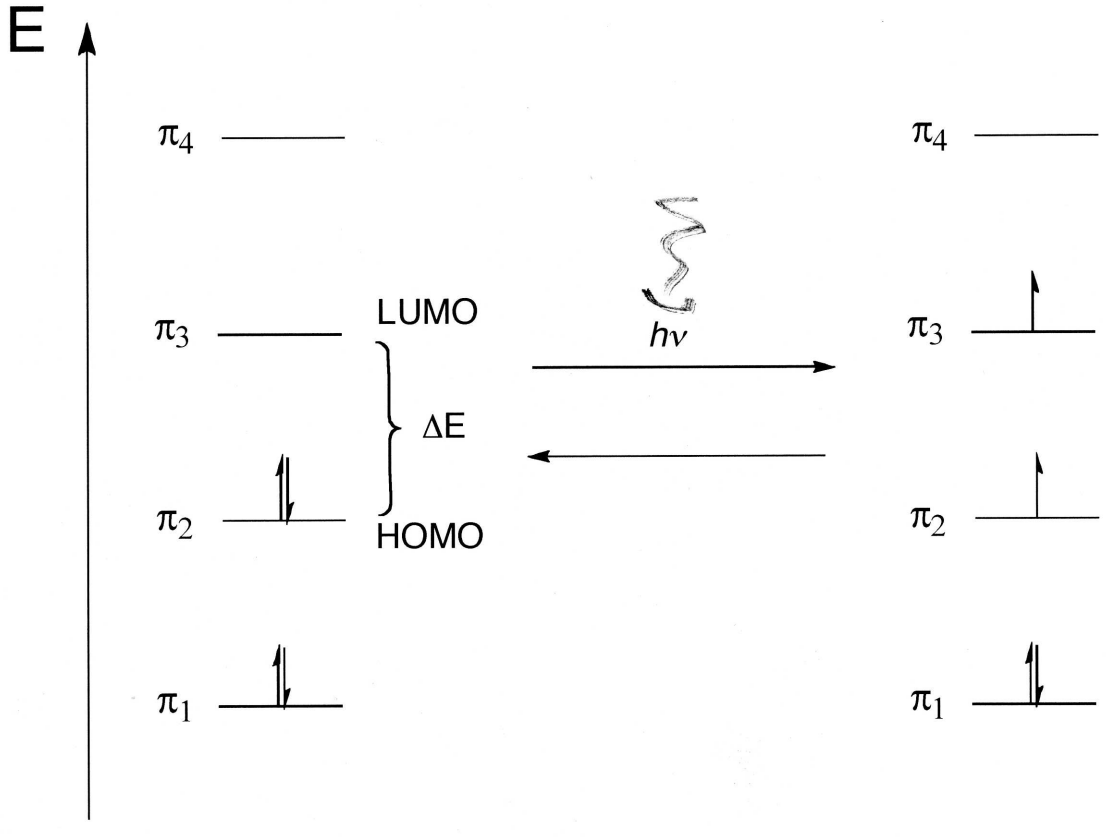
# Butadiene: the 4 carbon atoms all have a *2p* orbital

These **atomic** *2p* orbitals will combine to produce 4 π **molecular** orbitals
the number of atomic orbitals combined gives the same number of molecular orbitals




HOMO stands for Highest Occupied Molecular Orbital
LUMO stands for Lowest Unoccupied Molecular Orbital

# Molecules absorb energy at specific wavelength corresponding to ΔE



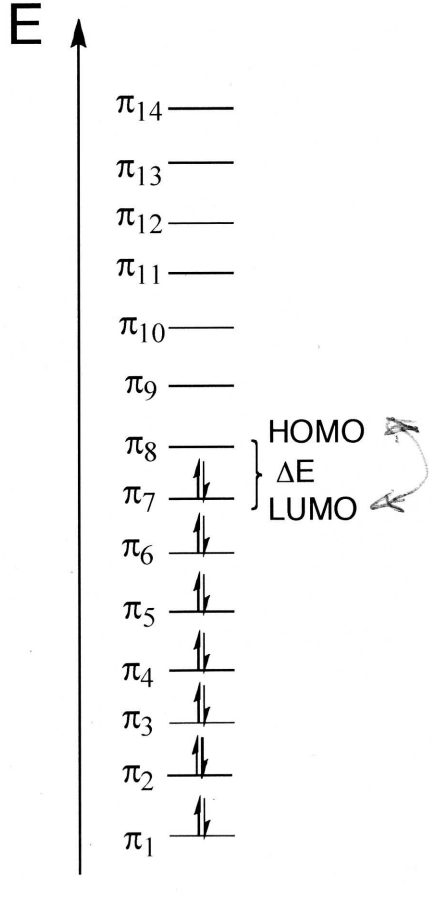

This is the basis for colour and photosynthesis

As molecule becomes more conjugated,
energy gap (ΔE) between HOMO and LUMO becomes smaller

molecule with ≥ 7 conjugated double bonds absorbs light between 4000 – 8000 Å
becomes visible to us

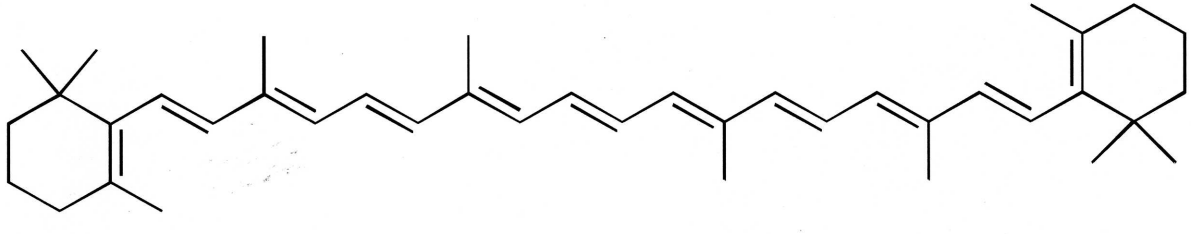
In this molecule, there are 7 bonding and 7 anti-bonding π molecular orbitals
Absorbs blue appears yellow

The energy gap between the LUMO and HOMO is quite small



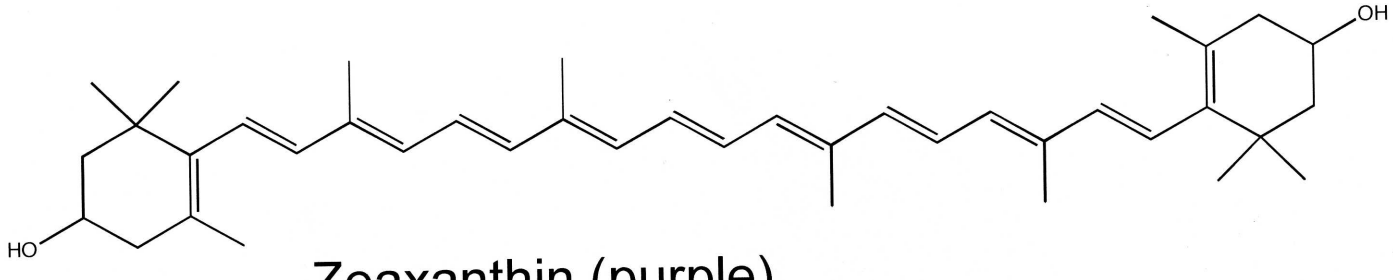
# Absorption and Reflection of Visual Light

| Absorbed Wavelength (Å) | Colour Absorbed | Visual Colour |
|---|---|---|
| 4000-4350 | violet – blue | yellow – green |
| 4900-5000 | blue – green | red |
| 5800-5950 | yellow | blue |
| 5950-6050 | orange – red | green |
| 6050-7500 | red | blue – green |

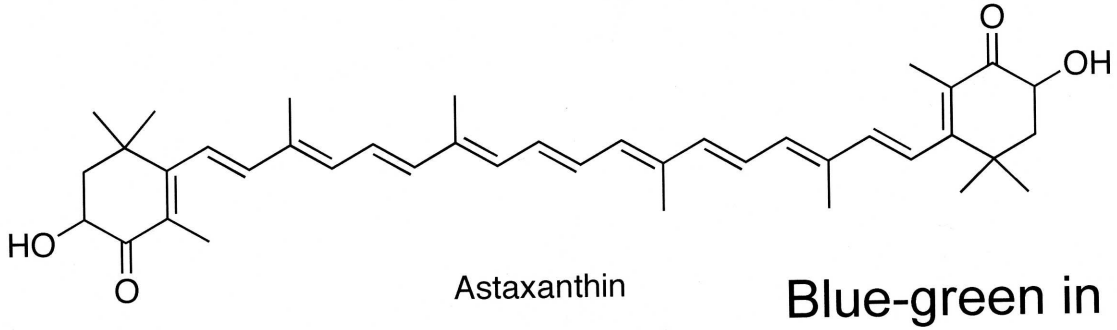


β-carotene

# Xanthophylls: oxygenated carotenes




Zeaxanthin (purple)

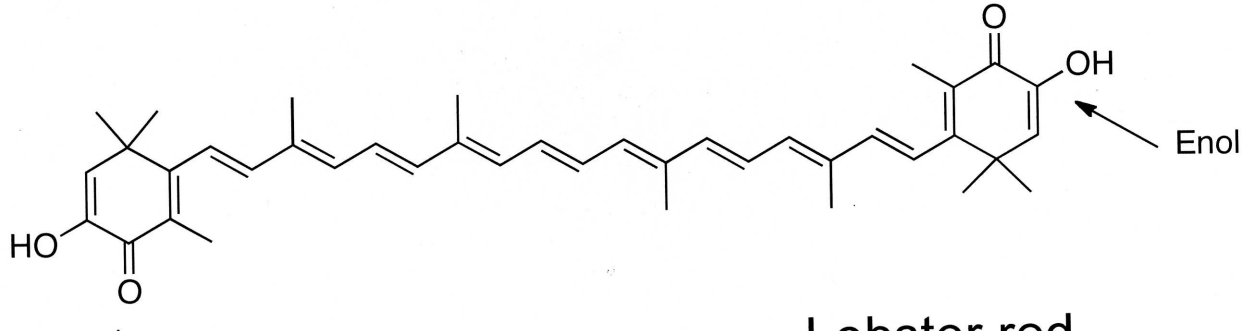



Astaxanthin

Blue-green in crustaceans

secondary alcohol

$H_2O$, $O_2$
Heat




Lobster red

Ketone

Astascene