

Xerophytes (Dry)

Plant adapted to live in **dry conditions**. Common adaptations to reduce the rate of transpiration include:

- **Thick waxy cuticle:** The cuticle cuts down water loss in two ways: it acts as a barrier to evaporation and also the shiny surface reflects heat and so lowers temperature.
- **Sunken stomata:** Stomata may be sunk in pits in the epidermis; moist air trapped here lengthens the diffusion pathway and reduces evaporation rate.
- **Leaf rolled with stomata inside:** The inner surface is covered in hairs. The rolled leaf and hairs both serve to trap moist air so reducing transpiration. In addition, a smaller surface area of leaf is exposed to the drying effects of the wind.
- **Small leaves:** Many xerophytic plants have small, needle shaped leaves which are often circular in cross section. This reduces the surface area and hence the evaporating surface. Spines protect the plant from animals, shade it from the sun and also collect moisture.
- **Extensive Shallow Root System:** Extensive shallow root systems tend to be circular in shape, allowing for the quick absorption of large quantities of water when it rains.

Hydrophytes (Wet)

Plant adapted to live in **extremely wet conditions**. Common adaptations to increase the rate of gaseous exchange:

- **Leaf Shape:** The submerged leaves are often highly dissected or divided to create a very large surface area for absorption and photosynthesis. It also minimises water resistance and hence potential damage to the leaves. In many cases, the *submerged* leaves are totally different to floating or *emergent* leaves on the same plant. The *emergent* leaves are usually much *less* divided, if not entire and have a more similar internal structure to those of land plants.
- **Lack of protective layer:** The epidermal layer shows very little, if any, sign of cuticle formation, as water loss is not a problem. All the surface cells appear to be able to absorb water, nutrients and dissolved gases directly from the surrounding water. As a result, the xylem tubes is often greatly reduced, if not absent. There are also no stomata on the underside of the leaves.
- **Location of Stomata:** The green pigment-containing chloroplasts important for photosynthesis are restricted to the upper surface of the leaves which are the only surface to be well lit. Stomata are also found only on the upper surface of the leaf. This upper surface often has a thick waxy cuticle to repel water and help to keep the stomata open and clear.
- **Presence of Aerenchyma:** They allow diffusion of oxygen from the aerial portions of the plant into the roots. Thus the roots don't have to depend on getting oxygen from the soil. "Regular" plants may have porosity (% air space in roots and stems) of 2-7% of their volume, while a wetland plant may be up to 60% pore space by volume. For a typical hydrophytic plant, air moves into the internal gas spaces of young leaves on the water surface and is forced down through the aerenchyma of the stem to the roots by the slight pressure caused by the heating of the leaves. The older leaves lose their capacity to support pressure gradients so gas from the roots returns out through the old leaves.
- **Stem and Lenticel Hypertrophy:** The presence of little or no mechanical strengthening tissue in stems and leaf petioles. If these plants are removed from the water, they hang limply. They are normally supported by water all around them and so have no need of mechanical strengthening. Mechanical support would be disadvantage as it would limit flexibility in the event of changes in water level or water movements.
- **Roots:** Roots are often also reduced and their main function is anchorage. The root hairs which function in absorption are often absent and roots themselves may be entirely gone.
- **Rapid Early Shoot Growth:** Under flooded conditions, several herbaceous and woody species exhibit this which gets the shoot above the surface of the water quickly to facilitate gas exchange.