In order to survive, terrestrial organisms (those living on land) must limit their water loss without compromising the efficiency of their gas-exchange systems.

Limiting water loss in insects:

The problem for terrestrial organisms is that **water easily evaporates from the surface of their bodies and they can become dehydrated**. However, efficient gas exchange requires a thin, permeable surface with a large area (features conflict with the need to conserve water) so they have adapted:

- **Small surface area to volume ratio**—minimise the area over which water is lost
- **Waterproof coverings**—over their body surfaces. In insects this is a rigid outer skeleton covered in a waterproof cuticle.
- **Spiracles**—the openings of the tracheae at the body surface and these can be closed to reduce water loss.

Because of these features, insects cannot use their body surface to diffuse respiratory gases in the way single-celled organisms do. **So they have a network of tracheae that carry air containing oxygen directly to the tissues.**

Limiting water loss in plants:

Terrestrial plants have a waterproof covering over parts of the leaves and the ability to close stomata when necessary. Certain plants have a restricted supply of water, have also **evolved a range of other adaptations to limit water loss through transpiration, these plants are called xerophytes.**

These are plants that are adapted to living in areas where water is in short supply. Without these adaptations these plants would die.

Limiting water loss

Main way of surviving habitats where there is a high rate of water loss and limited water supply is to reduce the rate at which water is lost through evaporation. These plants have these adaptations:

- **Thick waxy cuticle**: **the thicker the cuticle, the less water can evaporate**. (holly leaves)
- **Rolling up of leaves**: most leaves have their stomata on the underside (lower epidermis) so the rolling of leaves **helps to trap a region of still air**. This becomes **saturated with water vapour and so have a very high water potential**. There is no water potential gradient between the inside and outside of the leaf so there is no water loss. (marram grass)
- **Hairy leaves**: thick layer of hair especially on the lower epidermis **traps still, moist air next to the leaf surface. The water potential gradient between the inside and outside of the leaves is reduced = less water lost**. (a type of heather plant)
- **Stomata in pits or grooves**: again, **trap still, moist air next to leaf and reduce water potential gradient.** (pine trees)
- **Reduced surface area to volume ratio of the leaves**: the smaller the SA to VR, the slower the diffusion. **By having small and roughly circular cross-section leaves like pine needles, rather than broad and flat leaves, the rate of water loss can be considerably reduced.** This reduction in surface area is balanced against the need for a sufficient area for photosynthesis to meet the requirements of the plant.

Similar adaptations may be found in plants that live in sand dunes or other dry, windy places in temperature climates where rainfall is high and temperature relatively low. **These adaptations are essential because the rain quickly drains away through the sand and out of reach of roots, making it difficult for these plants to obtain water.**

Plants living on salt marshes may have their roots drenched in water but find it difficult to absorb it. Plants in cold regions also struggle to obtain water. **Most plants living in these conditions show xerophytic modifications to reduce transpiration and survive.**