Science Understanding

Biological Sciences:-

Multi-cellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment.

Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems.

Chemical Sciences:-

Chemical reactions, including combustion and the reactions of acids, are important in both non-living and living systems and involve energy transfer.

Physical Sciences:-

Energy transfer through different mediums can be explained using wave and particle models.

Introduction to the Red Mangrove (*Rhizophora stylosa*):-

YouTube Video https://www.youtube.com/watch?v=ujYcMT_nlsw

The Red Mangrove is one species of Mangrove tree that is found in the south eastern corner of Queensland, Australia. Some examples of Red Mangrove that are found in the northern reaches of Queensland can grow up to twenty metres in height whereas the majority of the species usually occur in the range of four to five metres.

Red Mangrove trees occur in coastal marine environments where they are exposed to inundation of salt water from the ocean twice in a twenty four hour period. The marine environment is highly dynamic with high current flow during tidal movement, desiccation during low tide, fluctuating

temperatures and salinity levels. The salinity level at the mangrove ecosystem in the video was measured at approximately thirty five parts per thousand (35‰).

It is important that the Red Mangrove obtain water in order to achieve production of carbohydrates through the process of photosynthesis.

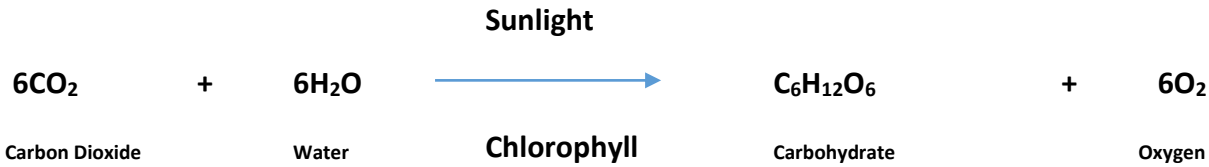

Fig.1. Process of Photosynthesis

But it is equally important that the Red Mangrove reduces the uptake of salts into the body of the plant.

The Red Mangrove, like the vast majority of plants, pulls water into their bodies through their root system. This process is called transpiration and is driven by evaporation.

The ocean water enters the roots of the plant at its base and passes along the Xylem tubes of the vascular system to the top of the plant and into the leaves.

The water then passes out of the leaves through small openings, usually found on the underside of the leaf, called stomata. The water does not merely drip out of the leaf in liquid form but evaporates into the surrounding atmosphere in the form of gas. Therefore we could suggest that the process of evaporation is the driving force behind transpiration. The heat required for the evaporative process is ultimately acquired from the Sun.

The salty marine environment can cause desiccation of the plants found there unless they are well adapted. In order to reduce the amount of water that can escape through the leaves of the Red Mangrove during transpiration the number of stomata are limited. The amount of gaseous water that can pass through the stomata opening is governed by guard cells found on either side of the stomata. These guard cells change their shape to either decrease or increase the size of the opening and hence decrease or increase the water loss.

The Red Mangrove leaves also have a thick waxy cuticle (waxy coating) on the upper-side of the leaves in order to reduce water loss.

The root system of the Red Mangrove is also well adapted for survival in the marine environment. The strong water currents caused by the ebb and flow of the tides is combatted by the tree growing aerial prop roots from the stem and the branches. As the name suggests, these prop roots help to prop up the plant during the periods of fast flowing water.

The roots of the Red Mangrove are buried into the coastal sediment in the intertidal zone which means that the spaces between the sediment grains are usually waterlogged and hence oxygen is not readily available for use by the cells of the submerged roots.

In order to compensate for the lack of oxygen the Red Mangrove aerial prop roots have lenticels on their surface. These lenticels are openings that allow air to pass into the root and then pass along “passages” of tissue called aerenchyma where gas exchange can take place. This ensures that the oxygen can be delivered to the cells that need it deep in the sediment.

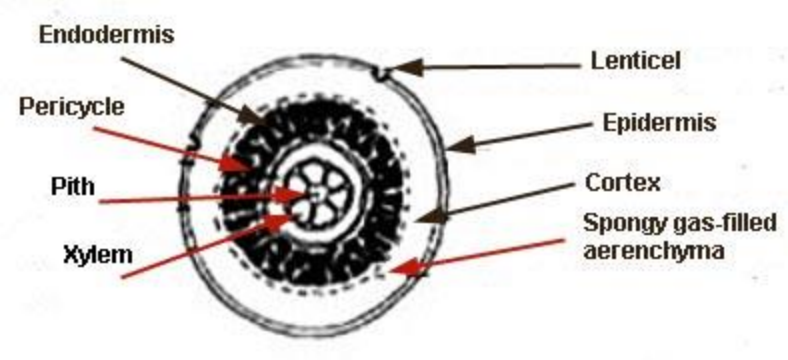

Fig. 2. Cross section of shoot showing lenticels, aerenchyma and xylem (MESA 2015)

Although the Red Mangrove root system facilitates the passage of water and oxygen into the body of the plant, it is also adapted to exclude salt. The root system contains a membrane that acts as a sieve. The membrane allows the relatively small water molecules to pass into the plant whilst blocking the passage of salts. Salts are relatively large ionic structures that cannot fit through the semi-permeable membrane and are hence excluded from entering the plant.

If salt does gain access into the body of the Red Mangrove it is ultimately stored in the leaves of the tree until they senesce and fall from the tree, taking the salt with them.

• Remember that mangrove trees obtain their water from the salty coastal marine environment.

• Remember that the process whereby the plant draws water through its roots and up into its leaf canopy is called transpiration.

• Remember that the Red Mangrove controls water loss from its leaves by regulating the size of the stomatal openings and maintaining a “waxy” cuticle on the upper surface of the leaf.

• Remember that the membrane processes of the Red Mangrove root system facilitates water and oxygen uptake but blocks the uptake of salts.

Student Quiz:-

1. What is the scientific name of the Red Mangrove?

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2. What is the salinity in parts per thousand (‰) of the ocean water found at the Mangrove forest in the video?

_____‰

3. What is the name of the process that draws water into plants through the roots and ensures the passage of water through the plant and into the leaves?

_____

4. Name the physical process that converts liquid water into gaseous water?

_____

5. List three adaptations that the Red Mangrove tree utilises to survive in the high salt environment.

   a._____
   b._____
   c._____

6. Give three examples and descriptions of how the Red Mangrove uses the aerial prop roots for survival in the coastal marine ecosystem.

a._____
_____
_____
b._____
_____
_____
c._____
_____
_____

7. Research the structure and describe how the stomata and guard cells work together to reduce water loss from plants.

_____
_____
_____
_____
_____
_____

Diagram representing Stomata and Guard Cells.