PENRITH LAKES
ENVIRONMENTAL EDUCATION CENTRE
EDUCATION FOR A SUSTAINABLE FUTURE

Science

Resource Sheets and Teacher Notes

Background information on wetlands

Wetland soils

Generally, wetland soils are poorly drained. They are described as **gley soils**. In extremely wet conditions, when organic matter accumulates faster than it can be broken down, **peat** soils develop. Wetland soils are characterised by a number of features:

• **sediments which originate from a wide range of sources** - sediments can be derived from all parts of the catchment via materials eroded by river, wind, tidal and wave action and from within the wetland itself.
• **frequently waterlogged** - the pore spaces of the soil or substrate are permanently or intermittently flooded by either surface or ground water which can be fresh, brackish or saline.
• **low in oxygen** - as the pore spaces are partly or completely flooded for a portion of the year, the rate of gaseous diffusion is slow. Oxygen diffuses some 10,000 times more slowly in water than in air, therefore wetland soils often have a shortage of oxygen.
• **usually organic and nutrient rich** - due to the low amount of oxygen, organic matter decomposes at a slow rate and so accumulates at the sediment - water surface. The upper layer of soil contains a large amount of nutrient matter.
• **contain various environmental toxins** - deeper in the soil profile, where there are extremely low levels of oxygen, biological activity by **anaerobic** micro-organisms such as bacteria produce a range of compounds including reduced ions (manganese 2+ and iron 3+), many of which are toxic to plant cells.
• **can be characteristically black in colour and produce an odour of "rotten eggs"** - in organic-rich soils, especially at high latitudes, sulphate may be used by some bacteria to produce hydrogen sulphide ('rotten egg' gas). In soils containing ferrous iron, the sulphide is removed from solution by the precipitation of very insoluble iron sulphide producing the black colouration and odour, common in nutrient-rich freshwaters and coastal mudflats.
• **can be a source of methane** - in the process of decomposition, anaerobic micro-organisms such as bacteria convert complex carbon compounds (sugars and starches) from dead plant and animal matter into simple molecules such as methane.
• **can accumulate salt** - this state occurs particularly in frequently flooded areas where evaporation rates are high. In inland locations, soil salts move towards the surface and may concentrate in the upper layer of the soil. Soils in intertidal zones exhibit high levels of salinity as salts are added by flooding of sea water at high tide, and as a result of groundwater mixing.

Water

Water is the most important element in the wetland habitat. The physical, chemical and biological functions which give wetlands their unique character and habitat value are influenced by the availability of water. Wetlands are maintained by hydrological processes, and play an important role in catchment hydrology.

Water quantity

The amount of water in a wetland influences its function, the composition and diversity of species, and the cycling of nutrients and pollutants. The **water budget** refers to the relationship between the amount of water that flows in via precipitation, surface run-off and groundwater, and the amount that flows out via evapotranspiration, surface run-off and groundwater.
It also includes water which is added and extracted by humans (such as disposal of saline groundwater or extraction for irrigation). This water budget changes from season to season and year to year to produce a natural fluctuation in the level of water in a wetland or its hydrological regime.

Three main types of inland wetland are distinguished by their principal source of water input:
1. River floodplains (includes billabongs, **anabranches**, shallow swamps and marshes). The major source of water in floodplain depressions is overland overflow from river channels.
2. Shallow basins (include lagoons blocked by a dune system, and drainage systems affected by lava

flows). The major sources of water are: surface run-off and precipitation from upstream in the catchment.
3. Groundwater depressions (include lowlying coastal wetlands and spring-fed wetlands). The major source of water is groundwater, where the **water table** periodically rises enough to wet the surface.

Seasonality

Wetlands are subject to annual and seasonal change in non-tidal wetlands. As the balance between water changes in response to climatic factors such as rainfall and temperature, the water depth in the wetland changes. Native wetland flora and fauna have evolved with annual and seasonal cycles. 'Wet' periods, when wetlands are full or partially inundated, are necessary for normal wetland functioning.
Occasional 'dry' periods are also necessary. Desiccation (drying out) of organic matter results in a flourish of biological activity when the wetland is refilled and large amounts of stored nutrients are released. A number of waterbirds, fish and amphibians are stimulated to breed by a sharp rise in water level (such as following a flood or heavy precipitation) which results in an abundance of food.
An example of a plant species that has evolved to take advantage of annual wetland cycles is the River Red Gum (*Eucalyptus camaldulensis*). It relies on annual winter - spring flooding for regeneration but cannot tolerate permanent waterlogging. The success of seedling regeneration depends on the timing and extent of flooding.

Typically a natural wetland shows a gradual decrease in water depth from the centre to the edge. Vegetation colonizes the shallower areas where sunlight reaches the substrate. These plants trap sediment and provide detritus, further reducing the wetland's depth. If people create or modify a wetland to become a steepsided impoundment , or create an even depth without shallow areas, this wetland will not be as good for wildlife because vegetation cannot establish and nutrient levels are often low.

Water quality

While quantity and seasonality of the water regime affect the composition and species diversity of a wetland, water quality also determines ecological processes and patterns. The following indicators are those most widely used to determine water quality in a wetland:

• **Dissolved oxygen** - oxygen is an essential element for the survival of most aquatic plants and animals. The sources of dissolved oxygen in water are:
the atmosphere - oxygen enters more readily when mixing occurs (such as in waves and fast moving or turbulent streams); and *photosynthesis* - via algae and larger aquatic plants.
• Cold water contains more oxygen because oxygen gas (like all gases) is more soluble in cooler water. The depletion of dissolved oxygen is caused mainly by accumulations of organic wastes in which anaerobic bacteria consume oxygen in the process of decomposition. Healthy wetlands, capable of supporting a diversity of organisms, usually have water with high amounts of dissolved oxygen.
• **Temperature** - many of the physical, biological and chemical characteristics of a wetland depend on water temperature. Temperature affects the solubility of oxygen in water (gases are more soluble in cool water than warm water), rate of **photosynthesis** by algae and larger aquatic plants (an increase in temperature increases the rate of photosynthesis), and metabolic rate of organisms (an increase in temperature increases the metabolic rate and accelerates growth). Some aquatic organisms tolerate a narrow range of temperature and will not survive an increase beyond that tolerance. Aquatic plants can tolerate temperatures of more than 20^0C. Most aquatic **invertebrates** prefer the 13 - 20^0C range.

• **pH** - pH is a measure of the hydrogen ion concentration in water. Most aquatic organisms are able to survive in the 6-9 pH range. Bacteria are able to survive in a wider range, from 1-13 pH. The acidity or alkalinity of water can be determined by the soil and parent rock characteristics, atmospheric emissions (via acid rain and snow), and heavy metals in inflowing water.

• **Turbidity** - turbidity is the amount of suspended solids in the water. Turbid water allows less light to penetrate the wetland and so lowers the rate of photosynthesis, which in turn reduces the amount of oxygen available to organisms. Turbid water is warmer because suspended particles absorb more heat from sunlight. The source of suspended solids may be: soil erosion, surface run-off or waste discharge.
• **Salinity** - salinity is the amount of dissolved salts present in water. The sources of dissolved salts in water are: the atmosphere, ground water and weathering rock material. An increase of salts in freshwater affects macrophytes, micro-algae and invertebrates because the cells of these organisms become dehydrated.
• **Total phosphorous** - refers to both organic phosphorus and inorganic phosphate. Phosphorus is an essential nutrient for plant growth and a fundamental element in metabolic reactions in plants and animals. The source of phosphorus in wetlands can be: fertilisers, detergents, animal wastes, garden and industrial wastes, forest fires and volcanic eruptions. Plant growth is limited by the amount of phosphorus available. An excess of inorganic phosphates can cause algal blooms.
• **Nitrates** - nitrogen (in the forms of ammonia and nitrate) is an essential plant nutrient and required by all plants and animals for building protein. The source of nitrogen in these forms in water can be: decomposition of aquatic plants and animals, excreta of aquatic organisms, human wastes from poorly functioning sewers, septic systems or wastewater treatment plants, as well as storm-water run off which washes animal excreta and agricultural fertilizers into wetlands.
Excessive amounts of ammonia, nitrates and nitrites can cause **eutrophication,** where the nutrient enrichment of the water stimulates rapid growth of plant material and phytoplankton, leading to the choking of the water or wetland.
• **Faecal coliform (E. coli)** - this is a measure of the bacteria derived from the faeces of humans and other warm and cold-blooded animals and soil organisms. These bacteria can enter wetlands as **effluent** via: direct discharge from organisms, agricultural and storm-water run-off carrying wastes, and sewage discharged into the water. If E. coli levels are high (over 200 colonies/100ml of water sample), there is a greater probability that pathogenic organisms are present.
• **BOD** (Biochemical Oxygen Demand) - BOD is the quantity of oxygen used by micro-organisms in the decomposition of organic matter. The BOD is determined by the amount of organic material in the wetland. Sources of organic matter are: leaves from **aquatic plants** and nutrients from detergents, fertilisers and sewage.

Adaptations to wetland conditions

Plants and animals have adapted to live in a wide range of fresh, brackish and saline aquatic environments. They have physiological and behavioural mechanisms which maintain the necessary balance of water and dissolved ions in their cells and tissues. This balance is achieved through **osmoregulation.** In this process the selectively permeable cell membrane in both plants and animals allows water to pass freely into and out of the cell. However, **solute ions** and other molecules must be actively transported into and out of the cell. These properties of the membrane maintain the balance of water, solute ions and other molecules required for normal functioning of the organism. Many **adaptations** are related to the maintenance of this balance.

Plants

Wetland plants use a range of strategies to survive in their frequently waterlogged and low oxygen environment. Some of these strategies are outlined below:

• **Development of air-filled tissues** - termed **aerenchyma** and **lacunae**, these are tissues with large intercellular spaces which facilitate gas loss from certain regions of the root. Gas loss results in site specific oxygenation of the root zone which allows the plant to take up nutrients from an oxygen depleted environment. An example of a plant demonstrating this adaptation is the Giant Rush.
• **Development of adventitious roots** - an avoidance strategy where plants grow a series of new roots (usually from the stem) into a less hostile environment, e.g. directly into air above the surface of the watterlogged sediment. In flood conditions, the plant has access to water which contains more oxygen and less

environmental toxins than the benthos or wetland mud. An example of a plant demonstrating this adaptation is the River Red Gum.

• **Dormancy period** - some plants avoid the stresses caused by excessive flooding or drying by: lowering their metabolic rate, losing leaves, and reducing their water uptake (and hence any toxins from the benthos or substrate which may be in solution). Examples of plants demonstrating this adaptation are: Water Ribbons which is dormant in the dry, and *Centipeda sp.* which is dormant in the wet.

• **Storage of carbohydrates** - wetland plants can store high levels of carbohydrates in their root stocks (such as **tubers** and roots).
This adaptation occurs in response to lower energy yields due to the limited oxygen availability, and enables the plant to survive periods of dormancy. Examples of plants demonstrating this adaptation are the Common Reed and the Bulrush.

• **Ethanol tolerance** - under low oxygen conditions wetland plants generate a large amount of their energy via alcohol fermentation - the end product of which is ethanol - which can be toxic. Tolerance is achieved by the plant by changing the end products to include lactate and malate, which are less toxic than ethanol. An example of a plant demonstrating this adaptation is the Giant Rush.

• **Surviving the salt** - salinity poses two problems for plants: how can cells obtain fresh water from a salty solution, and how do they regulate the salt balance in order to prevent invasion by potentially toxic ions, yet absorb essential elements for growth. Salt tolerant species have evolved a number of mechanisms to survive in this environment.

1. Development of **pneumatophores -** these aerial breathing roots have developed in mangrove species (particularly the White Mangrove), and allow the plant to tolerate regular flooding by salt water. Pneumatophores, which grow vertically from the main root, are exposed at low tide allowing the air-filled tissues to be ventilated.
2. Salt secretion - some salt tolerant plants (those colonizing saltmarsh, estuarine and salt-lake environments) are able to regulate their salt content via salt secreting glands on the under-side (epidermis) of leaves. The New Zealand Spinach demonstrates this adaptation.
3. Salt accumulation - prior to shedding of old leaves, some salt tolerant plants can redistribute ions within the plant to conserve nutrients (such as potassium and phosphorous) or lose toxic ions (such as sodium and chloride). Sodium and chloride are concentrated in the old leaves which are subsequently shed.

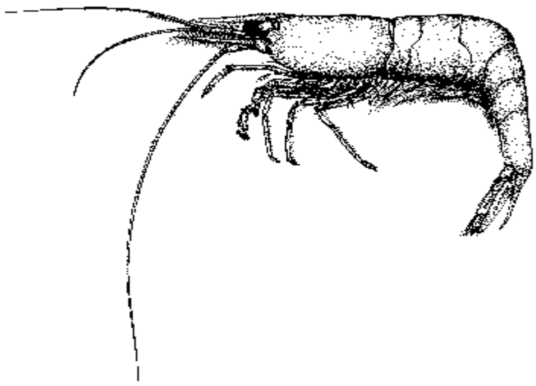
Animals

Animals, like plants, have a number of adaptations which enable them to survive in a wetland environment. A selected range of adaptations are outlined on the following pages.

Freshwater Shrimps

Size: up to 35 mm

Habitat: Freshwater Shrimps live in the shallow waters of still or slow moving lowland rivers and streams and standing freshwaters. They are found in every state in Australia.



Diet: Freshwater Shrimps feed on both animal and plant material scavenging for their food on the bottom of the water body. Shrimp make an important part of the food chain for fauna in streams

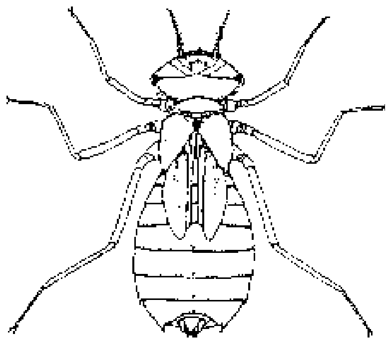
Description: freshwater shrimps are small, transparent (almost invisible except for their black eyes), quick moving animals. Shrimps may be recognised by their 5 pairs of walking legs and two long antenna. They do not have heavy armour like a crayfish for defence generally rely on their invisibility for defence.

Behaviour: they tend to congregate under banks, large submerged boulders and stones and amongst aquatic vegetation . They swim slowly in quiet waters but when they flick their tail they shoot backwards very quickly. Breeding season occurs in spring and early summer. The females brood their black eggs under their tails, giving them a very dark like appearance and these are quite noticeable. The larvae are then released after a short incubation period with large numbers of the planktonic larvae inhabit the water bodies.

Dragonfly larvae

Size: up to 50 mm

Habitat: these are amongst the commonest insects seen around fresh water habitats. Dragonfly larvae live under stones and amongst bark, branches and reeds in slow flowing pools and fast moving sections of streams. Dragonfly adults are swift fliers and feed on midges and other small insets which they capture during flight.



Diet: Dragonfly larvae feed on aquatic insects and crustaceans. They are predatory and a very efficient hunter. They have long folded back jaws that spring out and grab their victims.

Description: Dragonfly larvae have stout bodies with six legs and large eyes on the side of their heads. Some dragonflies have round bodies with others having long oval shaped bodies (this depends on the species). The adult dragon flies can come in a large variety of colours like red, orange, yellow, blue, green, black and purple. They have four wings which are always spread out like wings on a plane. They can not fold their wings back, this is how we identify them from Damselflies as Damselflies can fold their wings over their body. Adult dragonflies

Behaviour: Dragonfly larvae have a very special skill for swimming around creeks. They suck water into their stomach and then fart it out their bottom so its like a jet propulsion. They use this to get away from other animals bigger than them and to chase smaller animals. Eventually they climb up a plant and out of the water. They peel off their old skeleton to emerge as a winged dragonfly which hunts just as effectively over the surface of the pond.

Adult Dragonfly males live near water guarding a hunting and mating territory, they often have a favourite perch which they can look over their territory.

Physical characteristics that affect macro-invertebrates

• **Riffle, edgewater and pool habitats** vary in physical conditions which influence the type of macro-invertebrate communities that live there.

• **Current velocity** refers to how fast the water is moving. Riffles with current velocities of about 0.5 metres per second support the most diverse communities. Occasional floods may disturb your site and flush away some macro-invertebrates and plants downstream.

• **Bottom composition** - the river bottom is made up of different materials but cobbles (rocks of marble to basketball size) provide the best habitat for macroinvertebrates.

• **Flow (discharge)** - the amount of water in the channel determines how much of the river bed is exposed to air. When the river is drying up, animals will concentrate into remaining water holes. Some macro-invertebrates are better at coping with these conditions than others so the composition of the community changes.

• **Depth and water clarity** of the stream affect whether light can penetrate through the water column to the bottom and allow plants to grow. Plants provide shelter and food for macro-invertebrates.

• **Shading** provided by trees and other vegetation helps moderate extremes of water temperature in summer. Stream-side vegetation provides food (leaves, branches, bark) for aquatic animals. The growth rate of aquatic plants in heavily shaded streams tends to be slower.

• **Temperature** - small creeks in the upper end of the catchment are typically colder than those downstream. Some macro-invertebrates cannot tolerate warm water or wide variations in water temperature. In addition, as water warms, the level of dissolved oxygen falls and eventually stresses aquatic animals.

Aquatic chemistry and its effects on macro-invertebrates

The water in your catchment is a complex mixture of chemicals. The stream is affected by the composition of rain water, the geology of the catchment itself (such as limestone), animals in the water and by human activities. The most important chemical characteristics that affect macro-invertebrates are:

• **pH**. Acidity of the water is measured on a scale of zero to 14 pH units. Extreme pH conditions - less than 5 and more than 9 pH units - can be toxic to aquatic life.

• **Dissolved oxygen**. Macro-invertebrates and other aquatic animals take up oxygen that is dissolved in water. In still or slow flowing waterways with a high density of aquatic animals and plants, biological activity can lower dissolved oxygen to dangerous levels (less than 5milligrams per litre). Dissolved oxygen is added to water by plant photosynthesis during the day time and by water mixing with air as it flows over rocks.

• **Nutrients** (phosphate and nitrate) are essential for life. Lakes, ponds and slow moving streams tend to trap nutrients and silt. If nutrient levels are low, the water is usually clear and the number of macro-invertebrates is low. Increasing concentrations lead to more plant growth and more abundant grazing macro-invertebrates.

Biological characteristics that affect macro-invertebrates

The river is a living community of plants and animals which is dependent on getting food, oxygen and sunlight. The pattern of activity varies with the seasons. Macro-invertebrates are affected by:

• **the amount of available food**. Food comes from small aquatic organisms, algae, streamside vegetation and decaying food particles travelling from upstream. Some macro-invertebrates feed mainly on leaves and other food that drops into the stream from overhead vegetation; others eat algae. The amount of algal growth is affected by sunlight and nutrients. As the vegetation cover hanging over the stream opens up from the headwaters downstream, the type of food available changes and with it the composition of the macro-invertebrate community.

• **the seasons**. Macro-invertebrates hatching in summer will mature from egg to adult and will be larger and easier to find in the spring sample.

Human-caused changes in macro-invertebrate numbers and diversity

In order to survive, macro-invertebrates need specific ranges of environmental conditions, such as temperature, oxygen levels, pH and salinity. Changes in the water quality can therefore affect macro-invertebrates by decreasing variety (numbers of different types of macro-invertebrates), and leave only those species tolerant of poor water quality. In general, diverse communities tend to be more stable than less-diverse ones, and it is generally assumed that high levels of variety are desirable for a healthy community.

Pollution, while it can reduce the variety of species in the community, may lead to a greater number of those species that survive polluted conditions. These species usually increase in number because of the lack of other species, some of which compete with them for food and some of which feed on them.

Human activities in a catchment or within the stream itself can significantly alter the characteristics of macro-invertebrate communities and therefore affect animals higher in the food chain. Changes in sediment load, clearance of stream form, and increases in nutrient an effluent input all affect community structure.

Suspended solids can reduce light penetration and therefore limit photosynthesis, with consequences for macroinvertebrate diversity and numbers. Sediment deposited on the stream bed can smother bottom-dwelling communities and alter habitat by filling in holes and depressions.

Riparian vegetation supplies food in the form of organic material (leaves, bark, etc.). Removal of this food source will not only affect macro-invertebrates that feed on it, but also increase the amount of light reaching parts of the stream that the overhanging vegetation previously shaded. Loss of shade may result in an increase in algal production - conditions that will favour selected macro-invertebrates. Increased solar radiation may also raise surface water temperatures, further affecting the number and diversity of macro-invertebrates.

Removal of snags (woody debris) and the formation of channels will alter macro-invertebrate diversity significantly, by reducing the variety of habitat available for colonisation. Removal of snags is particularly important in sandy reaches of a stream, where they may be the only habitat for colonisation. It can also affect macro-invertebrate communities by destabilising the river bed.

Barriers, such as dams, can alter the natural flow, temperature and water chemistry through controlled releases from the cold bottom layer of the dam, disrupting the various life stages of many stream macro-invertebrates. They also obstruct the animals' drift or movement down the stream.

Increases in nutrients from catchment run-off (through erosion, salinity, sedimentation etc.) increase the potential for algal productivity. The macro-invertebrate community will respond to the changes in food supply and an increase in grazing macro-invertebrates will occur.

Sewage and industrial effluent contains many components, including toxic substances, such as heavy metals and pesticides, that can kill macro-invertebrates. As well, heated water reduces dissolved oxygen levels and disrupts macroinvertebrate metabolism which can also kill them. Severe organic pollution causes depletion of oxygen in the water and invertebrates are largely eliminated except for species such as tubificids (worms) and chironomids (midge larvae), which can tolerate low levels of oxygen. With less sever organic pollution, diversity is reduced but the abundance of tolerant species increases. The effect of pollution by toxic substances, like heavy metals, differs somewhat as different species have different tolerance ranges. However, as with organic pollution, the result is a reduction is species diversity and a change in the relative abundance of tolerant organisms.

What can macro-invertebrate communities indicate about the health of your waterway?

Monitoring, via sampling and identification, will reveal information about the macro-invertebrat community in your waterbody and will help you tell its story. When you sample you are collecting information on the community's abundance, diversity, composition and pollution tolerance.

Abundance refers to the number of macro-invertebrates present. Large numbers of macro-invertebrates tend to be found in water enriched with nutrients. Small numbers may indicate erosion, toxic pollution or scouring by floodwaters.

Diversity refers to the number of different types of macroinvertebrate present. Healthy streams usually have a greater diversity than degraded streams, although the diversity in headwaters can be naturally low due to a lack of different types of food. Communities with many different species appear to be more stable and healthy than less diverse ones.

Composition refers to the proportion of different types of animals living together. A sample from healthy streams tends to contain a good number of mayflies, stoneflies and caddis flies. the sample contains a lot of worms and midge larvae (chironomids), the stream is probably degraded.

Pollution tolerance refers to the tolerance of animals to organic pollution from sewage, industrial effluent and heated water. For example, most stonefly families are intolerant of pollution whilst worms are quite tolerant. Pollution tolerant animals do occur in natural streams where there is low dissolved oxygen, for example, in small clumps of leaves buried in sediment.

Pond Microbes

Ponds contain a rich diversity of microbes. This cross section of a pond shows the different habitats within the pond. The amount of light and oxygen change at different depths, creating different habitats for different microbes.

The green microbes growing closest to the top are green algae and cyanobacteria. This greer color comes from chlorophyll, a chemical that turns solar energy into food that the microbes ca use. The conversion of light into chemical energy is called photosynthesis. Deeper in the pond are other colorful bacteria that have either purple or green chlorophyll. Still deeper in the pond are sulfate reducers and methanogens which inhabit the dark, lower part of the pond.

Ponds are home to a huge variety of microbes that represent nearly all kingdoms of life.

Photosynthesizers
Plants are well known for their ability to convert sunlight into energy for food. This process is known as photosynthesis. Many other organisms can also convert the sun's energy into food, including many different algae and bacteria.

Algae
Algae are photosynthetic eukaryotic organisms. Waters contain a huge variety of algae including golden, yellow, brown, red, green, and yellow-green algae as well as diatoms. Algae can be microscopic or macroscopic, in which case they are known as kelp. At one time, scientists grouped algae together with the plant kingdom, but now algae are considered members of the kingdom Protoctista. The Protoctista is a kingdom of organisms which is neith plant, animal, fungus or bacteria. Like plants, algae are organisms which long ago formed a symbiosis with photosynthetic bacteria.

Photosynthetic Bacteria
Not only are plants and algae photosynthetic, but also some bacteria are photosynthetic.

Bacteria contain different types of chlorophyll which give them different colors.

Cyanobacteria
Blue green photosynthetic bacteria are called cyanobacteria. These were formerly thought to be algae, until scientists found that they had no nuclei, like other bacteria. Close relatives of cyanobacteria were probably the ancestors of the photosynthetic organelles (plastids) in modern plants.

Anoxygenic Photosynthetic Bacteria
In addition to blue green bacteria there are other types of photosynthetic bacteria. Unlike plants and cyanobacteria, these bacteria do not produce oxygen as a by product of photosynthesis and are therefore known as "anoxygenic."

Heterotrophs
Many microbes live in ponds and feed off of other organisms and decaying organic matter (detritus). Since they cannot produce their own food, these organisms are called "heterotrophs" which means "other eating."

Microbial Animals

Animals are generally studied in a branch of science called zoology. Since some animals are too small to be seen without the aid of a microscope, these animals are included in this Microbe Zoo. All animals are heterotrophs.

Sulfate Reducers
Some microbes breathe sulfate instead of oxygen. These bacteria, called sulfate reducers, thrive in sediments, such as those found at the bottom of a pond. Sulfate reducers are often found in the black colored zone of a pond because they convert sulfates into metal sulfides which are black.

Methanogens
Living at the bottom of the pond, furthest away from oxygen are the methane producers. These microbes also live in murky swamps, where they produce swamp gas, also known as methane. When there is no oxygen nor other electron acceptor, organisms called methanogen proliferate. Usually, the bottom of a still pond has no oxygen and is home to methanogens.

Try This!

Ponds are a fantastic source of microbes which are easy to see with the proper magnification. Scoop up some pond water in a jar and examine the water using a magnifying glass and/or a microscope. How many different types of microbes can you see? Compare the types of microbes you find at the top of the pond with those you find near the bottom of the pond. Why are the microbes near the surface different from those at deeper levels?