Name:

Junior Science

Cells and Living Things

Downloadable Resource

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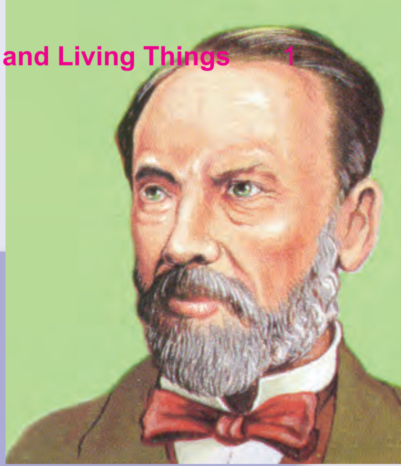
Sour Milk and Surgery



Louis Pasteur, 1822-1895

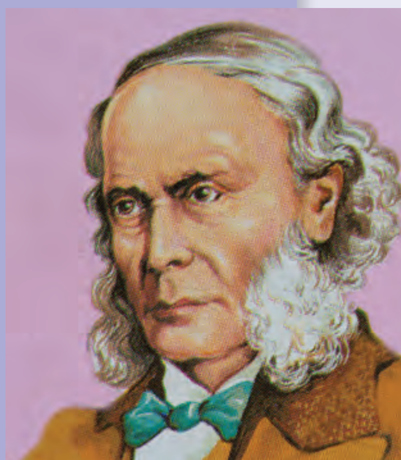
When you think about milk going off and forming those smelly lumps, there doesn't seem to be an obvious link to surgery and saving lives. But it is exactly this that an influential scientist discovered in order to reduce food spoilage and lead another scientist to create techniques that saved human lives.

The father of microbiology is a French chemist and microbiologist called Louis Pasteur, who lived from 1822-1895. He made important advances and discoveries in the areas of:

- Vaccination – using small amounts or weakened disease to build immunity by infecting healthy individuals with it.
- Microbial Fermentation – that fermentation that produces alcohol (used in beer and wine making) was due to microbes.
- Pasteurization – heating food products to kill any microbes and so increase the shelf life of the food.

Pasteur discovered that microorganisms exist and that they cause disease and rotting. He used sterilised jars (jars that had been heated) to show that no microbes would grow, then once he opened them and exposed them to the air, microbes grew. These findings destroyed the previously accepted idea that living things like maggots, mould, bacteria, diseases and even fleas came from non-living things like dust. It was thought that these 'bad' things came from nowhere and especially not from a living source.

While experimenting with wine and the yeast responsible for making the wine, he discovered the reason as to why the wine went off and became vinegary over time. Again it was due to other microorganisms like bacteria. He performed many tests and experiments and found that by heating the wine to between 60-100°C before bottling it, then putting it into sterile bottles, it stopped the wine going sour. This process became known as pasteurisation and is still used for a wide range of food products today such as beer, juice, eggs and water. The most common use of this technique is to prolong the life of milk. An unwanted bacterium in milk produces lactic acid which curdles it and makes it sour. After heating the milk, it killed the bacteria and allowed the milk to last longer. Based on these findings, he deduced that microbes must be the cause of human disease also and that we should attempt to prevent their entry into the human body. After his discoveries, he published several papers and reports that outlined his findings.



Joseph Lister, 1827-1912

A British surgeon called Joseph Lister saw Pasteur's work and found it enlightening. It led him to develop techniques in medicine that saved hundreds of lives. Lister lived from 1827-1912 in Kent, England. He studied mathematics, natural science and languages at school then went on to get a degree in the arts and botany. From here he enrolled in medical school and trained to be a surgeon. Before Lister made his world changing discoveries, people thought that infections obtained during and after surgery were from bad air. To prevent infection, hospitals would open their windows and doors to allow clean air to enter rather than washing hands, bedding and wounds. Even surgeons didn't wash their hands before performing surgery and they boasted about the number of stains on their surgical gowns. Lister read Pasteur's work and made the assumption that if microbes caused food to spoil then perhaps they also caused infections in human tissue. Pasteur had suggested three ways of killing the microbes and reducing infection:

- Filtering the air and fluids.
- Heating to a temperature over 60°C.
- Exposure to chemicals like acids.

Lister felt that the only acceptable method for treating humans was with chemicals. He experimented with carbolic acid and tested its effectiveness. He firstly used the carbolic acid to spray surgical instruments, wounds and dressings. From this he saw a massive decrease in gangrene and other infections. In fact the death rate after surgery before he introduced his new techniques was 46%. This decreased to just 15%. From his personal findings he proposed that all surgeons:

- Wear clean gloves.
- Wash their hands before and after surgery with weak carbolic acid solution.
- Wash their instruments in carbolic acid.
- Spray the operating theatre with the solution.

This use of chemicals to reduce disease and prevent microbial growth became known as 'using antiseptic'. Lister also gave lectures about the need for sterilisation, using antiseptics and the 'germ theory of disease'. He even gave advice to the surgeons of King Edward VII who needed his appendix removed. The King credited him with saving his life . In 1879, Joseph Lawrence created a liquid that was used to rinse the mouth in order to reduce the number of bacteria and prevent tooth decay and bad breath. This liquid contained antiseptic and he named it Listerine in honour of Joseph Lister.

Even though these two scientists worked in very different areas of science they were both able to advance human technology and both contributed massively to the modern world. It just goes to show the importance that scientists keep an open mind and have a diverse understanding of all areas of science across the world.

Classification of Animals and Plants

Living things can be classified or organised into different categories based on their features, behaviours and way of life. With modern science, scientists are even using DNA comparison to make a clearer picture of the groups that these things fit into.

There are three overarching **Domains** that all life fits into and these are:

- **Archea:** Simple single-celled microorganisms (similar to Eukaryote cells) that includes *thermofilum, ferroplasma* and *haloquadratum walsbyi.*
- **Bacteria:** Simple single-celled microorganisms made of prokaryote cells. These are cells that don't have membranes around their organelles. This domain includes heliobacterpylori bacillus, anthracis and clostridium tetani.
- **Eukaryota:** Complex life forms which are made up of eukaryote cells. These cells are more complicated than prokaryote cells and have membranes around their organelles. This domain includes plants, insects, animals and fungi.

There is much dispute about how organisms should be grouped but what is given in this article is a basic overview. We will be focusing on the third domain of Eukaryota for the next section.

Eukaryota is itself divided into the five main **Kingdoms** below:

Plantae (or plants)

- These produce their own food through photosynthesis and so are called autotrophs.
- They have indeterminate growth which means that they can keep getting bigger and bigger.
- Contain chlorophyll, so many appear green.
- Their cells have rigid cell walls and chloroplasts for photosynthesis.
- *Includes: ferns, mosses and flowering plants.*

Fungi

- These feed off other organisms and many are decomposers as they break down dead material like dead trees and animals. They are called heterotrophs as they don't make their own food.
- Have a similar morphology to both plants and animals but also differ to both.
- *Includes: mushrooms, mould and yeast.*

Protista (or protists or protozoa)

- These single-celled organisms can move by themselves.
- They are mostly heterotrophic.
- *Includes: paramecium and amoeba.*

Chromista

- These are sometimes grouped with Protista.
- They contain chloroplasts so carry out photosynthesis.
- The chlorophyll they have is different to plant chlorophyll.
- They have four membranes around their chloroplasts whereas plants only have two.
- *Includes: brown algae, diatoms and water moulds.*

Animalia

- Made up of many cells.
- Have a body shape that becomes fixed when they reach adulthood.
- They move freely during some stage in their life cycle.
- They are heterotrophs as they rely on other organisms for food.
- *Includes: 9 main groups called phyla.*

Animalia includes Porifera who have a body full of holes and channels that allows water to flow through freely. This phylum covers sea sponges like the stovepipe sponge and rope sponge. Cnidaria are jellyfish and are more complicated than the sponges as they have some organ systems and sensory organs. Sea nettles and box jellies both fall under this phylum. Flatworms or Platyhelminthes are flat in shape, live in water and have a branching gut system. Flukes and tapeworms are both types of flatworm. Hookworms and whipworms both fit into the phylum of Nematoda. Most of these are parasites that live in the gut of other animals; they themselves have a tube gut. Annelida are the segmented worms with long bodies divided into sections, with many having internal separations also. They are covered in mucus and rely on their skin for oxygen. Earthworms and leeches fall into this phylum. Animals with a hard shell and muscular foot including squid, snail and oysters fit into phylum Mollusca. The largest phylum of all Animalia is Arthropoda or the insects. They generally have an exoskeleton and segmented bodies like a suit or armour. Spiders, crabs and ants are all part of Arthropoda. Echinodea are marine dwelling organisms that generally have five point symmetry. This phylum includes starfish, sea cucumbers and sea urchins. The final phylum is Chordata, which is called this because the members have a spinal cord; they also have a tail during some stage of their life cycle. This phylum is divided into the six **Classes** outlined below:

Chondrichthyes

- Don't have hard bones.
- Are made of a cartilage skeleton.
- Have multiple rows of teeth.
- Have paired fins.
- *Includes: great white sharks and stingrays.*

Amphibia

- Reproduce in water.
- Start life as a larvae (like a tadpole).
- Cold blooded.
- Start with gills then develop lungs.
- Can also breathe through the skin.
- Lay eggs.
- *Includes: frogs and newts.*

Reptilia

- Cold blooded.
- Lay eggs.
- Have horny skin like scales.
- Have a three-chambered heart.
- Have lungs.
- *Includes: turtles and crocodiles.*

Osteichthyes

- Bony fish.
- Made of a bony skeleton.
- Have external scales.
- Have swim bladders to help with floating.
- *Includes: snapper and carp.*

Aves

- Have feathered wings.
- Are two legged.
- Warm blooded.
- Have a four-chambered heart.
- Lay eggs.
- Have a beak without teeth.
- *Includes: kiwi and geese.*

Mammalia

- Warm blooded.
- Give birth to live young.
- Have hair.
- Have mammary glands that produce milk for feeding their young.
- Four-chambered heart.
- *Includes: elephants and mice.*

As you can see, the way that living things are organised is a very complicated and well thought out structure. Scientists have tried for many years to make sure these things fit in a set of sensible groups. With each of these classes there are further divisions of Order, Family, Genus and Species.

For example, if we look at the **common black rat**. It has the following categorisation:

Domain: Eukaryota, Kingdom: Animalia, Phylum: Chordata, Class: Mammalia, Order: Rodentia, Family: Muridae, Genus: Rattus, Species: Rattus rattus.

Or **humans**:

Domain: Eukaryota, Kingdom: Animalia, Phylum: Chordata, Class: Mammalia, Order: Primates, Family: Hominidae, Genus: Homo, Species: Homo sapiens.

New Zealand Plant Groups

New Zealand is full of interesting, unique and rare plants. We have a vast number of different species that live in a wide range of habitats, such as the Hebe which with over 200 species can be found from the sunny shore line to icy mountain ranges and everywhere in between. Because New Zealand developed without many different species of large herbivores, our plants became very widespread and developed many new species and this is what has given us such a diverse plant library.

The smallest land plants that we find in the New Zealand bush are the **mosses and liverworts**. There are 550 species of moss and 500 species of liverworts in New Zealand. These simple plants grow in damp, cool and usually darker areas. You will find them attached to rocks, tree trunks or like carpets stretched across the ground. In fact, New Zealand is home to the world's largest leafy liverwort the **Schistochila appendiculata** which can grow over a metre in size. Mosses can be described as fluffy or furry looking whereas liverworts are shiny flat patches resembling a slice of fresh green liver. Neither of these two types of plants have stems, flowers or seeds and they have only very simple roots (little hairs called rhizoids) and leaves (called whorls). They are described as non-vascular plants which means that they don't have a system of tubes for transporting nutrients around (much the same as a human's circulatory system where blood moves through veins and arteries). Because they lack this system it limits the size that they can grow to. When a patch of bush or land is cleared mosses and liverworts are usually the first plants to grow. They form a thick carpet of many plants growing together. This is beneficial to them as it keeps them moist and close to other plants as it keeps the soil beneath them moist also. In order to reproduce, they require water as one phase of their reproduction involves movement through water and from this process they produce spores which grow into new mosses and liverworts. The **umbrella liverwort** (Marchantia polymorpha) has small cups on its surface that fling their reproductive parts away when hit by droplets of water. Mosses are slightly more complicated than liverworts and have a waxy coating that stops them from losing too much water. You can see mosses almost anywhere and the most widespread moss in the world is called **silvery bryum** which is described as an urban moss and is often found growing in cracks in footpaths and building. A very important moss that can be found throughout the world and is very successful at capturing carbon dioxide from the air is **sphagnum** moss. This moss is collected in New Zealand and sold to overseas countries such as Japan where it is used as a base to grow other plants.

Algae are also simple plants but these are usually found living and growing in water. These plants tend not to have any stems, roots, leaves or flowers and you have probably seen examples of algae at the beach. **Sea lettuce** is a commonly seen algae in New Zealand and can be found in the intertidal zone of a beach where the water is shallow so it can get plenty of sunlight. It is edible, which is why it is called lettuce but when it rots on the beaches it gives off a stinky sulfury smell like rotten eggs. Some algae like the seaweeds are large and others may only be a single cell or a collection of single cells in a thread. Euglena are a single celled algae that is found in most waterways. If it has plenty of nutrients then it blooms and forms green scum in the water. This blocks the light to other living things underneath and makes the water polluted and unhealthy. The larger algae species attach themselves to rocks or other submerged debris and have air pockets that allow them to float. A good example of this is **Neptune's necklace** which is seen in rock pools around New Zealand beaches. This seaweed has water and air filled bladders that look like beads of a necklace. Not only does this help it float but they also stop the seaweed from drying out during low tide. In fact, there are 850 native seaweeds in New Zealand ranging from the largest of the brown seaweeds, the Giant Kelp that grows in cooler ocean areas, to Gummy Weed that produces large amounts of slimy mucus to prevent itself from drying out. They also ooze this mucky mess when touched. Algae have chloroplasts and carry out photosynthesis so even though they are so diverse in shape and size, they are still classed as plants. For example the tiny algae **spirogyra** has spirals of chloroplasts that you can clearly see under a microscope. **Audouinella**, a type of red algae, can grow in dark, shaded spots under rocks or banks as it has a special type of chlorophyll.

Probably the plant that is most well known in New Zealand and how New Zealanders are known across the world is the **fern**. There are over 200 species of ferns growing in our bush, scrub and on the fringes of paddocks. They can be found growing as carpets across the forest floor or perched high up on tree trunks. Ferns are typically low-growing plants that cover exposed areas on the forest floor. They are able to cope with the lowered light levels and prefer the moist, darker areas as they rely on water for their reproduction, much the same as mosses and liverworts. They can grow a lot bigger than their mossy cousins and tall tree ferns can be seen in large numbers covering the sides of streams and steep gullies, where their lush green feathery tops stand out amongst the other trees. The **mamaku** can grow 20 m in height and the well-known Silver fern or **ponga** is also a tall tree fern. **Kiokio**, **bracken**, **ring fern** and **spleenwort** all act as cover plants that grow after mosses have established themselves on newly cleared or fire damaged areas. Ferns don't have flowers as they use spores to reproduce which again makes them similar to mosses and liverworts. They are unusual because they have two separate life stages. The form that we see ferns in is the adult stage that produces and releases spores. The spores grow into the other stage which is a small heart shaped, water reliant structure that reproduces and makes the adult fern. Another feature that makes ferns unique is their leaves which are called fronds. These are a central stalk with a flat blade that is divided into segments. When they are young they are coiled and unfurl into the wider frond shape. This coil is called a koru.

Some of the largest trees of our forests such as the mighty **kauri** or towering **tōtara** are **gymnosperms**. Kauri trees are found in the northern areas of New Zealand and are highly protected. They were milled heavily in the past because their wood is so strong, straight and each tree contains a massive amount of timber. Even the gum of the kauri tree was used for varnish and many settlers found employment as gum diggers. The word gymnosperm comes from the Greek for 'naked seeds' because they don't have their seeds inside a protective ovary like flowering plants do. Gymnosperms are usually large trees that have cones instead of flowers. In New Zealand there are around 20 native species of gymnosperms. The beautiful kahikatea or white pine can be found towering in low lying forests at a huge height of 55 metres. This tree had many uses such as boat building, waka and because of their lack of odour, export butter boxes. Most gymnosperm timber is classified as hardwood because the trees themselves take a long time to grow and due to this, the wood they produce is very dense. **Mataī** or black pine has a unique cone style. It is almost like a fruit of a flowering plant as it has soft juicy fruit covered scales, instead of the hard scales found on a pine cone for example. The Kereru eats these sweet, purple scales and the seeds inside. They then fly away and spread the seeds. The trees have male cones that produce pollen which gets spread by the wind and when it lands in a female cone, it fertilises it to produce seeds. When ripe, the cones open and the seeds are released where they are usually spread by the wind. Formerly called red pine, the **rimu** tree is another large tree that was heavily milled for its strength and beauty. Many pieces of furniture were made from rimu timber. Gymnosperms can grow in a large range of areas but aren't well suited to the extreme cold of higher mountain levels. The introduced species of **radiata pine** is the main tree used to produce timber and paper in our modern era, as it grows a lot faster than our native gymnosperms but still produces strong, straight wood. It is said that many plants in this group have needle shaped leaves to help them live in colder, windier areas as this prevents the leaves from drying out or being damaged by snow and ice.

There are 2000 native **angiosperms** in New Zealand and these are probably the most diverse looking group of all the plant groups. They are the flowering plants, so they use flowers of all descriptions to reproduce. The reason there are so many is because by having bright coloured flowers they attract insects and use them to spread their pollen which is a much more effective method than relying on the unpredictable wind like gymnosperms do. Most flowers contain both male and female parts but in order to reduce self-pollination they don't come ready at the same time. The flower itself turns into a fruit containing the seeds. Fruits can be soft and juicy like strawberries or peaches but they can also be hard like walnuts and coconut. Many angiosperms are small like **flax** or **toetoe** but some grow into large trees like **kōwhai** or **pōhutakawa**. There are two main types of angiosperms and they are placed in these groups depending on the number of food storage (cotyledons) areas they have in their seeds. Think of a green pea which can be split into two even halves, whereas a corn kernel can't. The first type is the monocotyledon (like the corn kernel) they have one food storage area and green or white flowers. Monocotyledons also tend to use the wind for pollination and have straight vertical lines in their leaves. Think about the leaves of a flax bush or **cabbage tree**. The other type are dicotyledons (like the pea) which have two food storage areas, brightly coloured flowers and branching veins in their leaves, like a **hebe** and the **rātā** tree.

Single-Celled Organisms

Single-celled organisms or unicellular organisms as they are also known, are living things that are made of only one cell. Generally they have well-structured and complicated cells much the same as animals and plants, except unlike animals and plants which are made up of millions of different cells, they are only one cell in size. They have similar organelles that do similar jobs but their single cell works by itself, whereas animal and plant cells work together with other similar cells to form tissues and organs. Two examples of single celled organisms are paramecium and euglena.

There are over 800 different species of **euglena** that exist in fresh and salt water. They prefer shallow and unmoving water such as in ponds or puddles and if they form in large enough numbers they can create a green slime in the water. Their numbers tend to snowball when the water is polluted with fertilisers such as where water runs off farmland.

Model of a green euglena.

The inside of the cell is filled with a jelly-like fluid called cytoplasm which gives the cell shape and contains many materials needed for many reactions like photosynthesis to occur. Near the front of the cell is a star shaped organelle called the 'contractile vacuole'. This removes any extra water that enters the cell and without it the cell could become so full of water that it would explode.

Euglena have chloroplasts and can make their own food by photosynthesis. The chloroplasts absorb the light needed for photosynthesis and are rod-shaped structures inside the cell. Being an autotroph or autotrophic means that the organism produces its own food which is usually through photosynthesis and includes cells that contain chloroplasts. Euglena are not completely autotrophic though. Euglena can also absorb food from their environment through their cell membrane during times of poor light.

Attached to the front end of the euglena is a flagellum, which is a long whip-like organelle that acts like a tiny outboard boat motor. The flagellum twirls around and pulls the cell through the water. The Euglena is unique in that it is both heterotrophic (must consume other organisms for food) and autotrophic (can make its own food). Also at the front end of the euglena is an eyespot that is used to detect light. This gives the euglena a sense of where the most sunlight is coming from so that they can use their flagellum to position themselves in the right place and maximise photosynthesis. The euglena has a stiff outer membrane that helps it keep its shape and holds the cell together.

Near the centre of the euglena cell is its nucleus and within the nucleus is the nucleolus. The nucleus contains the DNA (which resembles squiggly strands or threads) and has the role of giving the cell all necessary instructions.

Paramecium are found throughout all water sources and also prefer still, non-flowing ponds or stagnant pools. They are often used in biological studies and science laboratory investigations because they are easily grown and demonstrate many biological behaviours such as reproduction that can be studied over a shorter time. . Without paramecium, many food chains would struggle to exist because they eat other microorganisms such as different types of algae and euglena and many small animals rely on eating them for energy.

Model of a paramecium caudatum.

The cell is surrounded by tiny hairs called cilia which have an oar-like motion that allows the cell to move through water. The outer cell membrane of the paramecium is quite thick which means that it has a fixed shape. Just inside the cell membrane are teardrop shaped organelles called trichocysts. The paramecium can shoot tiny threads out of these to tangle up a predator, hold onto food or use them to make themselves seem larger.

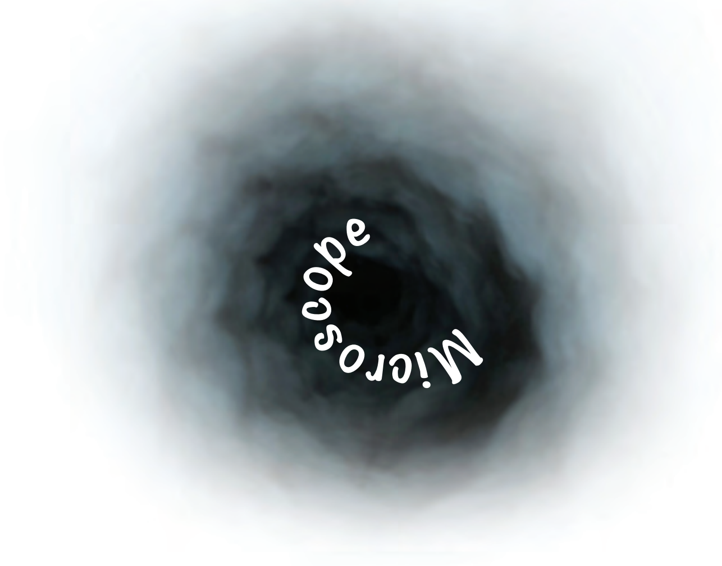
The inside of the cell membrane is filled with a jelly-like material called the cytoplasm. Near the end of the cell is the large nucleus that contains DNA and is responsible for controlling all of the cells processes. Like the euglena the paramecium has a star-shaped contractile vacuole to help it deal with the influx of water it experiences from living in a watery environment.

Paramecium are not autotrophs like euglena and in fact they are heterotrophs. This means that they must eat other organisms in order to gain energy. Cilia lining the oral groove, pass food particles along the surface of the oral groove and down into the gullet (found at the end of the oral groove). At the end of the gullet, food vacuoles are formed and you can see one forming in the picture in your workbook. These are small pieces of membrane that pinch off around food particles. Food vacuoles stay in the cytoplasm until the food is digested. Undigested food particles and any wastes are removed through the anal pore which is found near the cell membrane and shows waste being ejected from the cell.

Word Games

1. Terminology Tornado

Using the following science term, see how many words of 3 or more letters you can make in 10 minutes.



Points
3-4 letters = 1 point
5+ letters = 2 points

Scores
0-5 points = awful
6-10 = average
10+ = amazing

2. Six Word Scramble

Use the clues to work out what the 6 key science words are and then spell the word in the grid by colouring in the squares that make up the word. Use different colours for each answer.

IN	TOP	AGE	YG
EN	OW	ANI	CY
ST	LASM	OX	SM
TH	ORG	STA	GR

Clues

a. Clear jelly-like centre of a cell. (9) ____________
b. Used in respiration and made in photosynthesis. (6) ____________
c. Where you sit the specimen on a microscope. (5) ____________
d. A living thing. (8) ____________
e. The ability to get bigger and mature. (6) ____________
f. Used to make specimens or parts stand out more. (10) ____________

3. Block Buster

Cross out each of the words that fit with one of the clues. You will be left with one word that doesn't fit; this is your answer.

sugar	ferns	eyepiece lens	carbon dioxide	movement	birds	
base	respiration	gymnosperms	condenser	dichotomous	nose piece	
barrel	sensitivity	fish	amphibians	mammals	light source	mosses
water	energy	chlorophyll	liverworts	oxygen		

Clues

a. Microscope parts.
b. Signs of living things.
c. Animal and plant groups.
d. Materials involved in photosynthesis and respiration.

Answer

____

4. Crossword

Across

3. The process through which carbon dioxide enters a leaf.
8. Angiosperms have these instead of cones.
9. carbon dioxide + water + light ⟶ energy + oxygen
10. Gives a plant cell structure and protection.
14. Animals and plants carry out this process to get energy from their food.
15. The small openings in the leaves that allow the movement of gases and water.

Down

1. Contains the DNA in a cell.
2. The total magnification when the eyepiece lens is 10x and the objective lens is 10x would be _____ ____________x.
4. This group of plants produce cones and usually have needle like leaves.
5. These have different strength.
6. The class that both humans and dogs belong to.
7. The diffusion of water.
11. This covers many leaves to prevent water loss.
12. The outer layer of cells on a leaf.
13. This is a common underground Annelida.

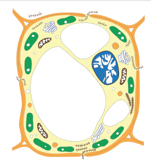
5. Lingo Lattice

All of the answers to the questions are in the lattice below, either as a word or picture. Once you have found each one, there will be one left over, this is the final answer.

Questions

1. Which shows a generalised plant cell?
2. What is made up of cells working together for a common purpose?
3. What sort of concentration does diffusion happen from?
4. Which is the ability of living things to produce offspring?
5. Which is an animal cell with a flagellum?
6. Which is a hole in the leaf of a plant?
7. What is the movement of water?
8. Which is the area of a leaf that does the most photosynthesis?
9. What carries out respiration?
10. Which is a piece of glass used to hold specimens?
11. Which is a green pigment that captures sunlight energy?

Final Answer

high	reproduction	osmosis
		
tissue	stoma	palisade layer