Variation

Name _____

Class _____

Teacher _____

L1 Variation

Variation is all the differences that exist in a population of the same species. These differences are caused by:

- **Genetic variation** - these are differences between individuals that are inherited from parents, such as the colour of your eyes, hair and skin.
- **Environmental variation** - these are differences between individuals that are not inherited but caused by the environment that the organism lives in, including scars and tattoos.
- **Genetic and environmental variation** - differences between individuals that are caused by both genetic and environmental factors, such as height and weight.

Data on variation is collected by surveying the population. This data can be described as either continuous variation or discontinuous variation. It is important to remember that these are not the causes of variation, which are described above, but how we analyse the results of the surveys.

Surveys of *continuous variation* give us results that come in a range. Human height is an example of continuous variation. It ranges from that of the shortest person in the world to that of the tallest person. Any height is possible between these values, so this is continuous variation. For example, you can be 150 cm tall, 151 cm tall, or any height in between this - if you had a ruler that could measure small enough values.

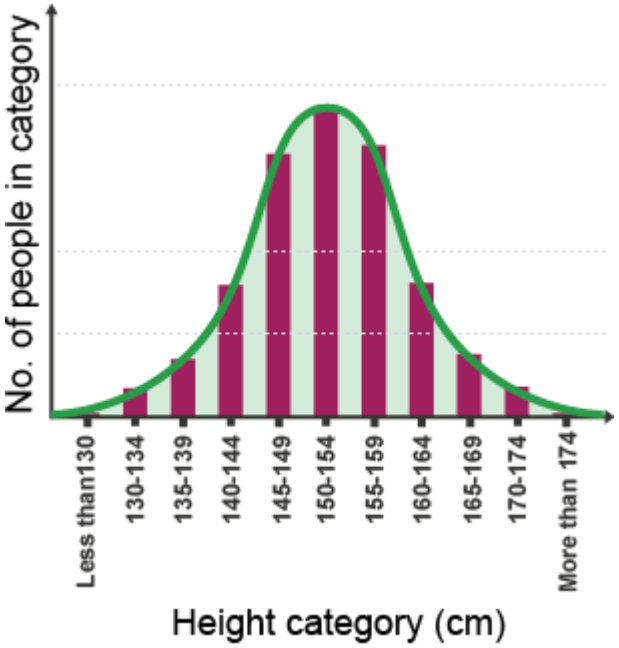
So, a characteristic that changes gradually over a range of values shows continuous variation. Examples of such characteristics are:

- height
- arm span
- weight

Results from surveys of continuous variation are presented in line graphs or bar charts with a *line of best fit* drawn through them. If you record the heights of a group of people and draw a graph of your results, it usually looks something like this:

Normal distribution

Surveys of continuous variation often give us results in a characteristic shape seen in the green line on the graph above. If there are fewer readings at either ends of the scale and far more in the middle, we see a bell-shaped graph of normal distribution. The more people you measure and the smaller the categories you use, the closer the results will be to this shape.



Discontinuous variation

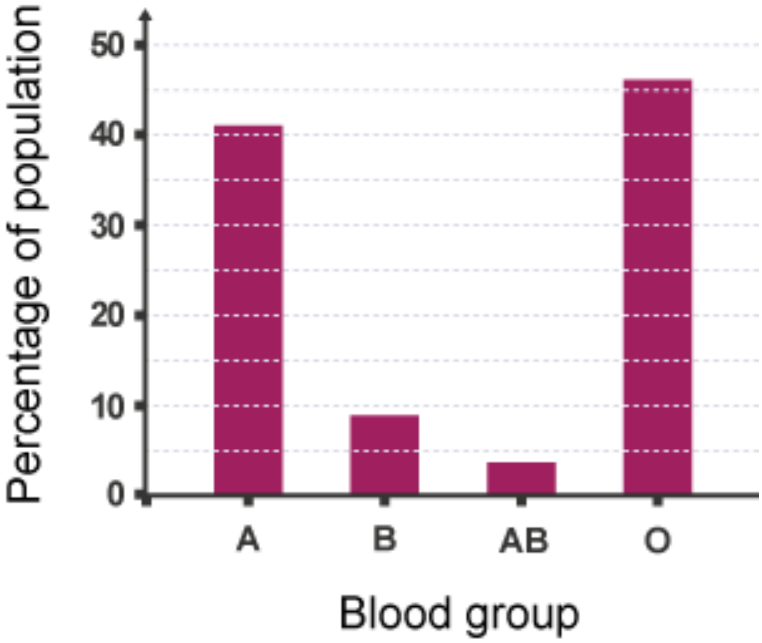
Surveys of discontinuous variation give us values that come in groups rather than a range. Human blood groups are an example of discontinuous variation. In the ABO blood group system, only four blood groups

are possible - A, B, AB or O. You cannot have a blood group in between these four groups, so this is discontinuous variation.

Here are some examples:

- blood group
- eye colour

Results from surveys of discontinuous variation are presented in charts. These is no line of best fit drawn because the values on the x-axis - blood groups in the graph below - could be placed in any order. If you record the blood groups of a group of people and draw a graph of your results, it usually looks something like this:



More examples

- Continuous variation Discontinuous variation
- Height Blood group
- Weight
- Hand used to write with
- Arm span
- Eye colour
- Head circumference at birth
- Ability to roll tongue

<u>Independent practice</u>

1. What is variation?
2. What are the three types of variation?
3. What type of variation is this, and why? eye colour, hair colour, accent, language, blood type, height, weight, tattoos.
4. What is a survey of a population?
5. What two types of data can be collected?
6. Describe continuous variation and give examples
7. Describe discontinuous variation and give examples
8. What kind of graph is used for continuous variation and what sort of distribution would you expect to see?
9. What kind of graph is used for continuous variation and what sort of distribution would you expect to see?
10. Extended writing: explain why twins separated at birth look and sound different. How would you expect one twin in America to look and sound in comparison to the other twin in Africa.

L2 Species

A biological species is a group of organisms that can reproduce with one another in nature and produce fertile offspring.

The following are reasons in which new species can arise:

1. Isolation (When two populations of a species are separated, geographically)
2. Genetic variation (Different alleles controlling different characteristics)
3. Natural selection (Certain alleles make it more beneficial for the organism as it helps them survive)
4. Speciation (Interbreeding cannot take place as the population has become too different)

Extinctions occur when there are no remaining individuals of a species still alive. The following are factors which may contribute to the extinction of a species:

1. Change in the climate - species cannot adapt to it
2. New disease - species cannot fight off the disease
3. New predators - species become the prey and they die off
4. New competitors - species struggle to survive as they cannot find their own food
5. Humans - humans may start hunting a specific type of animal for their own benefits
6. Catastrophe - single event can wipe out an entire species

Traditionally living things have been classified into groups depending on their structure and characteristics in a system developed by Carl Linnaeus. The linnaean system of classification groups living organisms into small yet specialised groups, based on their structure and characteristics. Linnaeus classified living things into kingdom, phylum, class, order, family, genus and species. Organisms are named by the binomial system of genus and species. The five kingdoms are: animals, plants, fungi, protists and prokaryotes. As evidence of internal structures became more developed due to improvements in microscopes, and the understanding of biochemical processes progressed, new models of classification were proposed. However through genetic analysis of DNA sequences in the recent years, the current classification system has suggested that organisms should be classified under three domains, rather than five. Through looking at DNA sequences, scientists have found that the closer the species are in relation, the fewer differences can be found within the DNA sequence.

Carl Woese is one of the main scientists has updated the classification system, and has divided organisms in the following groups: Archaea (primitive bacteria - cells that live in extreme environments, has no nucleus and has an unused section of genes), bacteria (true bacteria - bacteria cells with no nucleus and no unused section of genes), and eukaryota (including protists, fungi, plants and animals - they have a nucleus and have an unused section of genes)

A species is a group of similar organisms that can breed with one another to produce *fertile* offspring. For example, humans are one species and dogs are another species.

Individuals of the same species can reproduce to make more individuals of the same species. Two individuals belonging to different species cannot normally reproduce together. If they do, their offspring is often *infertile* and unable to reproduce.

Ligers and tigons

Sometimes individuals from two different species can reproduce. For example, animals called ligers are produced when a male lion and a female tiger reproduce. Tigons are produced when a female lion and male tiger have cubs. Unlike many young from hybrid species, ligers and tigons can have offspring.

Independent Practice

1. Recall what we mean by the term species
2. Describe how different species differ.
3. Explain how hybrids differ from species.
4. What is a species?
5. Give reasons for which new species can arise?
6. When does extinction occur? Give all reasons for extinction.
7. What does the Linnean system classify groups into? And what are these groups based on?
8. How are these groups named?
9. What are the five kingdoms?
10. Which technological advancement changed classification?
11. Extended writing; explain Carl Woese contribution to the classification system

L3 What are fossils

Although dinosaurs lived many millions of years ago, we know that they existed because some of them turned into fossils when they died. A fossil is physical evidence of a prehistoric plant or animal. This may be their preserved remains or other traces, such as marks they made in the ground while they were alive.

Fossilised remains - including fossil bones and teeth - are known as body fossils. Fossilised shells are also body fossils.

Other fossilised signs of a plant or animal are called trace fossils. Dinosaur trace fossils include footprints, imprints of their skin or feathers, and poo - called coprolites.

Do all living things turn into a fossil once they die? No! Very few things do. A specific set of circumstances and conditions are needed for fossilisation to occur, so it is actually a very rare event.

Most things that die rot away completely, leaving nothing behind.

Nearly all fossils we find - around 99% - are from marine animals such as shellfish and sharks. This is because they lived in the sea, where sand or mud could bury their remains quickly after they died.

Shark teeth are particularly common fossils

Once remains are buried under sediment, their decomposition slows down due to a lack of oxygen, giving enough time for fossilisation to occur.

But dinosaurs lived on land, so how did they get buried quickly enough for some of them to fossilise? Most of the dinosaur fossils we find are from animals that were living near to a lake or river. Some died shortly before the area flooded and covered their remains in mud and silt. Others were washed into a river by heavy rain. We don't know about many dinosaurs that lived in jungle or mountain environments. Fossils are very unlikely to form in such situations.

The most common way an animal such as a dinosaur fossilises is called petrification. These are the key steps:

1. The animal dies.
2. Soft parts of the animal's body, including skin and muscles, start to rot away. Scavengers may come and eat some of the remains.
3. Before the body disappears completely, it is buried by sediment - usually mud, sand or silt. Often at this point only the bones and teeth remain.
4. Many more layers of sediment build up on top. This puts a lot of weight and pressure onto the layers below, squashing them. Eventually, they turn into sedimentary rock.
5. While this is happening, water seeps into the bones and teeth, turning them to stone as it leaves behind minerals.

This process can take thousands or even millions of years.

The water leaves mineral crystals behind in spaces in the bones. This is why dinosaur fossils often have a sponge- or honeycomb-like texture: the internal bone structure has been preserved. Tree

fossils, also known as petrified wood, form in the same way. This is why it's possible to count the growth rings of some fossil trees.

Sometimes ground water dissolves the buried bone or shell, leaving behind a bone- or shell-shaped hole or imprint in the sediment. This is a natural mould. If water rich in minerals fills this space, crystals can form and create a fossil in the shape of the original bone or shell, known as a cast fossil. Or sediment can fill the mould and form a cast fossil.

These are the most common ways that marine animals with shells fossilise. This includes ammonites that went extinct at the same time as dinosaurs, as well as shellfish that are more like the limpets, oysters and mussels we can still find living on the beach today.

Trace fossils such as footprints form in a similar way. The footprint forms a natural mould and sediment then fills it forming a cast.

How do we find fossils when they've been buried under millions of years' worth of rock? It's down to a combination of uplift, weathering and erosion (plus luck).

Earth's surface is broken up into huge, irregularly shaped pieces - tectonic plates - that fit together like a jigsaw. These plates drift around very slowly, driven by heat from within Earth.

In certain parts of the world, these plates will collide. This can force areas of rock together and push them upwards. In the most dramatic instances, such uplift can form mountain ranges. This is why fossils of marine animals can be found at the top of Mount Everest.
In places that were once covered by huge, heavy ice sheets that have now melted, rocks also undergo uplift. Rocks can also be pushed up slowly by new igneous rocks forming underneath them.

Uplift is only part of the story. Weathering and erosion from wind, rain, ice, heat and rivers break rocks apart and wash the fragments away. It can take millions of years, but gradually fossils become exposed at the surface where we can find them, because of how they form, fossils occur in sedimentary rocks. So if you're going fossil hunting, that's where you should look.

<u>Independent practice</u>

1. Describe the process of fossil formation.
2. Recall what fossils can tell us about organisms which lived a long time ago
3. How do we know that dinosaurs lived?
4. What is a fossil?
5. Give some examples of fossils?
6. Why do all dead organisms not for fossils?
7. Where do most fossils come from and why?
8. What slows down decomposition?
9. Extended writing; Explain petrification
10. How does a cast fossil form?
11. Explain why fossils can be found at the top of mount Everest

L4 What is the fossil record

Fossils are preserved remnants or traces of organisms from a past geologic age. These are often found in sedimentary rocks. The fossil record is the documentation of the history of life on Earth based primarily on the sequence of fossils in sedimentary rock layers called strata (singular: "stratum"). The arrangement of fossils in strata gives us an idea of what organisms existed at what point in geologic time. Other types of fossils like insects preserved in amber and mammals frozen in ice also provide useful information.

Scientists use the fossil record to figure out when important events took place. They do this by dating rocks and fossils.

Sedimentary strata

The sequence of sedimentary strata tells us the relative ages of fossils: fossils found in strata approaching the bottom strata are increasingly older; while fossils found in strata approaching the top strata are increasingly younger.

Let's say we identified six strata in an excavation site, which we have labeled strata 1 to 6 from top to bottom. Even without determining the exact age of the fossils, we can infer that a fossil found in stratum 1 is younger than a fossil found in stratum 2. Likewise, a fossil found in stratum 6 is older than a fossil found in stratum 5.

Fossil record provides evidence of evolution

Natural selection is a process where individuals with traits that help them survive in their environment are able to reproduce more and pass on those traits. Over time, natural selection leads to a gradual change in the heritable traits of a population of organisms, a process we call evolution.

Charles Darwin viewed the fossil record as evidence of evolution

Darwin described evolution as “descent with modification.” This means that different species share a common ancestor, but evolve in different directions.

Specifically, Darwin showed that, at different points in geologic time, different species emerged as the traits of pre-existing species gradually changed. He argued that this "descent with modification" occurs because of natural selection.

First life on Earth: microbial mats of cyanobacteria

The fossil record shows that 3.5 billion-year-old microbial mats of cyanobacteria that lived in hot springs and hydrothermal vents are the earliest known life forms on Earth. Microbial mats are communities of prokaryotes that are structured as multi-layered sheets. Microbial mats are found in different environments including lagoons, lakes, and tidal flats.

Fossilised microbial mats are called stromatolites. Stromatolites are made up of laminated structures that are formed through the precipitation of minerals by prokaryotes.

In the first 2 billion years of the Earth, only anaerobic organisms were able to live. Anaerobic organisms are organisms that do not require oxygen to survive and grow. The emergence of cyanobacteria, which are blue-green algae capable of producing oxygen, made it possible for other life forms to evolve on Earth.

Emergence of cetaceans

The fossil record provides evidence that cetaceans--an order of marine mammals that includes dolphins, porpoises, and whales evolved from terrestrial mammals like hippopotamuses, pigs, and cows. Fossils show that the pelvis and hind limb bones of extinct cetacean ancestors became smaller over time, eventually disappearing completely and developing into flukes and flippers.

Mass extinctions

There are five strata in the fossil record where there seems to be a sudden and dramatic disappearance of species, which indicates that there have been at least five mass extinctions to date. Mass extinction is an event wherein over half the extant species disappear worldwide. It is believed that the sixth mass extinction—referred to as the Anthropocene period—has already begun as a result of human activities.

Alongside evidence of mass extinctions, the fossil record also shows how much time it took for biodiversity--the total variation of life--to recover. The fossil record indicates that the longest biodiversity recovery took about 30 million years. This information helps scientists predict contemporary extinction rates and come up with possible conservation measures to prevent human-caused extinction.

While the fossil record provides us with important data, we need to keep in mind that it is incomplete for the following reasons: Many organisms were not preserved as fossils because they did not die under the right conditions for fossilization. In fact, fossilization is so rare that scientists believe that only around 0.001% of all animal species that have ever existed have become fossils. Even if fossils were formed, many were destroyed by geologic events. Even if fossils survived those geologic events, many fossils have yet to be discovered.

For these reasons, the fossil record is biased towards species with the following characteristics: Species that existed for a long time. Species that were abundant in environments where scavengers could not take or destroy their remains. Species that had hard shells, bones, teeth, or other parts that kept their remains from being destroyed after death.

The fossil record is incomplete and biased, yet crucial in our understanding of evolution. To fill gaps in information, scientists continue to search for fossils as well as other evidence of evolution including molecular data.

The fossil record is the documentation of the history of life on Earth based primarily on the sequence of fossils in sedimentary rock layers called strata.

Sedimentary strata and radiometric dating are two common methods of determining the age of fossils. The sequence of sedimentary strata tells us the relative ages of fossils.

Radiometric dating estimates the ages of fossils by measuring the decay of radioactive isotopes.

Darwin used the fossil record to provide evidence of evolution. He showed that, at different points in geologic time, different species emerged as the features of pre-existing species gradually changed.

While the fossil record provides us with important data, we need to keep in mind that it is incomplete and biased because fossilisation rarely happens.

Independent Practice

1. Recall what we mean by the term fossil record
2. Describe some of the conclusions biologists have made from the fossil record.
3. Evaluate the evidence given by the fossil record.
4. What do scientists use the fossil record for?
5. What is a stratum?
6. What do we know about fossils found in the bottom strata compared to the top strata?
7. How does the fossil record give evidence for evolution?
8. How long ago did microbial mats of cyanobacteria live?
9. What is an anaerobic organism and how long ago did they live?
10. What did cyanobacteria and algae produce to make other life possible?
11. There is evidence to show that land mammals evolved into what sea creatures?
12. What do the strata tell us about extinction?
13. Extended writing: evaluate what the fossil record tells us and why it is important