Adaptation, natural selection and evolution

I HATE MY JOB!

Thanks to global warming that stupid bear'll never get us way out here.

THE MIRACLE OF ADAPTATION
### Learning Intentions

- Give the meaning of the term mutation.
- State that mutations may be neutral, confer an advantage or a disadvantage.
- State that mutations are spontaneous and are the only source of new alleles.
- Give two environmental factors which can increase the rate of mutation.
- Give the meaning of the term adaptation.
- Give examples of adaptations which allow a species to survive.
- State that adaptation may be structural, physiological or behavioural.
- Describe examples of behaviours which allow a species to survive.
- State that variation within a population makes it possible for a population to evolve over time in response to changing conditions.
- Describe natural selection/survival of the fittest.
- Describe the process of speciation.
Mutation

• A mutation is a **random** change to the **genetic material** of an organism

• Mutations are rare, random and **spontaneous**

• Mutations can alter the phenotype or functioning of the organism.

• Mutations which occur in sex cells are inherited by offspring, they are the only source of **new alleles**, and can alter the phenotype or functioning of the organism.
Types of Mutation

• Mutations can be neutral, an advantage or a disadvantage

• **Neutral** – these have no effect on the organism

• **Confer an advantage** – for example the peppered moth mutation which made moths dark in colour – this allowed them to be camouflaged in industrial areas with soot covering trees

• **Confer a disadvantage** – for example a gene mutation in chromosome 7 in humans leads to cystic fibrosis
Moths...how many can you see?
Mutagenic Agents

- The rate of mutations can be artificially increased by environmental factors such as:
  - Radiation such as X-rays, UV light, gamma rays
  - Chemicals like colchicine, mustard gas and benzene.
Variation

• Variation is the differences between members of a population
• It occurs due to differences in genetic information
• Organisms that survive allow a population to evolve over a period of time in response to changing environmental conditions
Adaptations - COPY

• An adaptation is a variation which makes it more likely that an organism will survive.
• An adaptation is an inherited characteristic.
• Adapted organisms are better at competing for food, fending off disease and escaping predators.
• They are more likely to survive and produce offspring so the genes which allowed them to survive are passed on!
A desert habitat

• A desert can have very little rainfall.
• There is a lot of sunshine during the day and very little shade.
• The temperatures can get very hot.
• At night it can become very cold.
How are plants adapted to survive in the desert?

- A cactus has a long taproot to reach water deep under the ground.
- It has a thick, fleshy stem to store water.
- It has needle-shaped leaves to prevent water loss through the stomata (pores on leaves).
- The needles help to stop animals from eating it.
How do desert animals survive

• The desert rat has **behavioural** and **physiological** adaptations to conserve water

• **Behavioural** adaptations – remain in underground burrows during the day and are active at night

• **Physiological** adaptations – no sweat is produced and they produce a small volume of very concentrated urine
An arctic habitat

• This sort of habitat can have extremely low temperatures.

• The ground is covered with white snow for most of the year.
How are animals adapted to survive in the Arctic?

- Animals like polar bears will have a thick insulating coat.
- They usually have a large amount of body fat.
- They have a large body size to surface area ratio.
- They have a camouflaged coat.
Adaptation Experiment Instructions

• Collect a basin of ice water.
• Place one finger in the ice water and record how long you keep it in (without too much discomfort).
• Cover one finger in vaseline and a plastic bag/glove.
• Place the covered finger in the ice water and record whether you can keep it in for longer.
• Write a short report on how you demonstrated the effects of insulation.
Adaptation Experiment – Result Table

<table>
<thead>
<tr>
<th>NAME</th>
<th>TIME WITH EXTRA INSULATION (minutes/seconds)</th>
<th>TIME WITH EXTRA INSULATION (minutes/seconds)</th>
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Types of Adaptation - COPY

- Adaptations can be behavioural, structural or physiological.

<table>
<thead>
<tr>
<th>Adaptation</th>
<th>Description</th>
<th>Examples</th>
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</thead>
<tbody>
<tr>
<td>Structural</td>
<td>A structural adaptation involves some part of an organism's body.</td>
<td>Camouflage, Teeth</td>
</tr>
<tr>
<td>Physiological</td>
<td>A change within the cells or tissues of an organism in order to increase survival</td>
<td>Gazelles can run fast to escape predators, Camels conserve water by producing concentrated urine</td>
</tr>
<tr>
<td>Behavioural</td>
<td>Things that organisms do to survive in habitat</td>
<td>Hibernation, Migration</td>
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</table>
Types of Adaptations - Activity

• Collect a set of cards.
• Sort each of the adaptations into structural, physiological or behavioural.
Types of behavioural adaptations - Copy

• Behavioural adaptations can be **innate** or **learned**. Both types increase the chances of survival.

• Innate behaviour is controlled by **genes** and is instinctive. E.g. Woodlice moving away from dry and light conditions.

• Learned behaviour is not genetically controlled and involves the **learning** or **modification** of a skill. E.g. Chimps learning to catch termites using a stick.
Review Questions

1. State why it is important that organisms show variation
2. State what is meant by the term adaptation
3. Explain why organisms living in deserts need to be adapted to survive
4. State 2 factors that might cause environmental conditions to change
5. State the 3 broad categories to which all adaptations can be classified as belonging
Natural Selection

• All species produce offspring to allow the survival of the species
• They produce more offspring than the environment can sustain
• This leads to a “weeding out” process based on the idea of survival of the fittest
• Only the best adapted survive to reproduce
• They pass on genes that confer a selective advantage to their offspring
• Natural Selection was first put forward by Charles Darwin in his book The Origin of Species on 1858
• Clip
Green fish live in a pond
One of the fish produced are blue - camouflage
PREDATOR arrives
Green fish targeted more readily

Blue fish survive to breed
Population characteristics change -

There are more blue fish than green fish because they have better camouflage.
Mutation creates variation

Unfavourable mutations selected against

Reproduction and mutation occur

Favourable mutation more likely to survive

...and reproduce
1. Read the five stages of natural selection and put them in order.

2. Once the order has been checked, create a flow chart of natural selection in your jotter.

3. Collect a natural selection case study sheet – make a mindmap of the key information.
Antibiotic resistance in bacteria

Intro Clip

Mutations create variation in bacteria.

Some mutations are fatal. Those that survive reproduce.

More mutations and reproduction occur, some of which make bacteria resistant to an antibiotic.

Only those that resist the antibiotic survive and reproduce (this is natural selection).
Rapid Selection

• Bacteria such as MRSA are resistant to antibiotics because of natural selection
GM crops have been genetically modified to lessen the effects of intensive farming on the environment.

Farmers spray insecticides to stop crops being eaten by insects.

GM crops have been modified to contain a gene that produces a toxin; if insects eat the crop they die.

Fewer chemicals are used due to the plants inbuilt resistance.

The effectiveness of this technique has reduced because insects that have a natural resistance to the toxin have survived and passed on the advantageous allele to their offspring. This has resulted in a greater loss of crops.
Speciation

- Speciation is a process that allows a new species to develop
- Speciation occurs after a population becomes isolated and natural selection follows a different path due to different conditions (selection pressures)
- Speciation requires 4 processes to take place;
  - Isolation, mutation, natural selection, time
Isolation by barrier

Sub-population B

mutation

Sub-population A

Natural selection

Further natural selection leads to two new species

Barrier removed

Species A is distinct (can not breed with) from species B

Large interbreeding population of one species
Isolating barriers

Overview

Song

• Barriers in Speciation can be geographical, ecological or reproductive

• Geographical e.g. River or mountain

• Ecological e.g. Differences in temperature and water availability

• Reproductive e.g. Sex cells that cannot fuse or mating displays that don’t attract members of another population.
Speciation

• Read the statements on speciation in the worksheet.
• Discuss them in pairs and decide the order of the statements
• Check your answers
• Stick the statements into your jotter in the correct order.