

**MIDDLE SCHOOL**

**Biotechnology**

**Adaptation Sensation**

**Teacher Background**: There are, essentially, 3 ways that an organism can be modified. 1) natural selection over time, 2) cross-breeding and hybrids, and 3) genetic modification. Today, the lesson will focus on natural selection.

**Teacher Background Information:**

* See “Cat Adaptation: Teacher Background Information” sheet
* Non-linguistic representation simply means using non-verbal demonstrations to express an idea or concept. Research shows that this increases student learning, especially for non-native English speakers and can help bridge the achievement gap.

**Pre-requisite:**

* General understanding of natural selection

**Goal:** To learn various physical adaptations cats possess to aid in their survival

**Objectives:** Students will…

* Predict adaptations
* Apply metaphor for each adaptation
* Reflect on how this relates to humans
* Write metaphors for human adaptations

**Materials:**

* 1 copy “Adaptation Sensation: Teacher Background Information”
* Costume supplies that act as metaphors for each adaptation
* 30 copies “Adaptation Sensation: Student Chart: Cats”
* 1 copy “Adaptation Sensation: Teacher Chart: Cats”
* 1 transparency “Adaptation Sensation: Student Chart: Cats”
* 1 color transparency “Adaptation Sensation: Humans Now and Then”
* Overhead projector

**Time Required:**

* Two 50 minute class periods

**Standards Met:**

* Life Science Standards: Diversity & adaptations of organisms

**Procedure:**

Prep

* Review the “Cat Adaptation: Teacher Background Information” to familiarize yourself with details
* Put together costume items

Day 1

* Explain to students that they will be considering different physical adaptations that cats have slowly developed over time in order to help them survive
* Define adaptations as a class (as it applies to natural selection)
* Review the concept of natural selection
* Tell students that the class is going to use non-linguistic representations (a non-verbal, visual representation) for a cat’s adaptations. Ask for one student volunteer to play “kitty”.
* Give the students the “Adaptation Sensation: Student Chart: Cats”. Explain that you will provide a metaphor for each of the physical attributes listed. The students’ job is to fill in the object acting as a metaphor and brainstorm as a class what skills that might give a cat to help it survive.
* Place each item on the cat and have the class brainstorm what purpose that adaptation might serve. Give students accurate information and fill in the chart on the overhead.

Day 2 (this could be completed for homework)

* Project the pictures of “Adaptation Sensations: Humans Now and Then”
* Give each student a copy of “Adaptation Sensation: Student Chart: Human”.
* Explain the directions and that they are mimicking the process of the cat adaptations.
* Have students “Think, pair, share” with an elbow partner, writing additional adaptations on their charts.
* Ask each group to share one physical attribute, reason for adaptation, and metaphor (costume item).
* Students should complete their charts.

**Extension/Homework:**

* Students can bring in metaphor items to showcase an “evolved human” and share during class, OR students can complete Human Adaptations at home.

**Adaptation Sensation: Teacher Background Information**

**Eye adaptations:**

The ancestors of domestic cats, and other wild cats of similar size, primarily prey on small rodents, and these animals tend to be most active at dusk and during the night. The eyes of the cat are adapted to perceive objects in dim light, which is an obvious advantage in hunting. Cats have large eyes and the pupils are able to dilate widely in poor light. This allows as much light as possible to enter and fall onto the sensitive layer, called the retina, at the back of the eye. The retina of mammals contains special receptor cells, called rods and cones. Rod cells are sensitive to light of low intensity because of the presence of a pigment called rhodopsin (visual purple). The pigment alters when stimulated by low intensity light rays, and this causes nerve impulses to be generated, which are sent along the optic nerves to the brain where they are interpreted. Cone cells are stimulated by bright light and produce sharper images than rod cells. They are responsible for the detection of color, containing pigments that alter at different wavelengths.

Cats' eyes contain a high proportion of rod cells compared to cones, a ratio of 25 rods to each cone. Experiments have shown that the cone cells of the cat are sensitive only to blue and green and there is no perception of red. Cats, in common with many other mammals, have a layer called the tapetum lucidum behind the retina, which is stimulated for a second time producing an intensified image. The tapetum lucidum can be clearly seen if a light is shone into the eyes of a cat at night when they appear to glow a greenish-yellow color-'cats' eyes'. Compared to human beings, cats have poorer daytime and color vision. They are able to detect moving objects better than static ones. In poor light, however, the visual acuity of the cat greatly exceeds that of a person and, combined with its other keen senses, helps to make it a superbly efficient twilight hunter.

**Ear adaptations:**

Cats have relatively large, pricked and highly mobile ears, which can collect and deflect sound rays inwards towards the eardrum and the organs of hearing. Cats are able to detect rounds with higher frequency wavelengths in the ultrasonic range up to about 65 KHz. However, noises with lower frequency wavelengths below 30 KHz are not able to be heard. Observation of a cat leaves one in no doubt as to the accuracy with which it can locate and identify sounds. Since cats hunt by stealth, crouching, prowling and finally pouncing upon their prey, it is a great advantage to be able to hear the slightest rustle in the grass and the high-pitched sounds made by their rodent prey.

**Smell adaptations:**

Cats have an acute and highly developed sense of smell and, in common with many mammals, possess a special pair of small olfactory organs located near the roof of the mouth. The vomeronasal, or Jacobson's organs, contain cells that are sensitive to chemical odors and, when stimulated, transmit signals along nerve pathways to the brain where these can be identified and interpreted.

Occasionally a cat can be seen 'snuffing' a scent and curling its lip as though in disgust. In fact, what the cat is doing is directing the air it is inhaling through the vomeronasal organs better to detect the chemical particles that it contains. The part of the brain concerned with the interpretation of odors is relatively large, showing the importance of this sense in the life of a cat. The animal uses its olfactory sense to detect and interpret the scent messages, or pheromones, left by other cats in the area. This means that cats have a means of chemical communication, used primarily to advertise their sexual status and, in the case of males, to mark their territory.

**Whiskers:**

Cats have a well-developed set of whiskers, growing mainly from the cheeks on either side of the nose. These are long, stiff, strong hairs, each associated with sense cells that are very sensitive to touch. The whiskers are used by the cat to 'feel-' its surroundings and are particularly useful at night. They can be used to gain information about the dimensions of spaces or objects, to detect movement or vibration and in interactions with other cats and with people. Similar sensory hairs occur along the back of the front legs (the 'carpal hairs'), and these, along with its whiskers, provide a cat with a highly developed sense of touch.

**Balancing Skills:**

Cats are agile and sure-footed climbers with a highly developed sense of balance. Their claws enable them to obtain a good grip while climbing and the tail is used as a counterbalance. The organs of balance are the fluid-filled, semicircular canals within the inner ear, from which information is continually conveyed to the brain and interpreted. The processing of all information relating to spatial position, nature of the surface on which the cat is climbing, visual data, etc, is very rapid.

Electrical signals are sent to appropriate groups of muscles so that a cat is able to move rapidly and keep its balance even in difficult circumstances. Of course, as is well known, cats do sometimes get into difficulties and have to be rescued from high places, being too afraid to attempt a descent. A cat may also sometimes misjudge the distance of a jump, or lose its balance for some other reason, and fall. If a fall occurs, a series of 'righting reflexes' rapidly come into play so that a cat usually lands in an upright position on its paws. This helps to lessen the risk of injury but cannot prevent it altogether, especially if the cat falls from a height onto a hard surface. However, cats are popularly believed to possess 'nine lives' and are well known for their remarkable escapes from tricky situations. The characteristics described above are mainly responsible for the supposed nine lives of a cat.

**Teeth:**

Cats possess the teeth of a true carnivore, adapted for killing prey and eating flesh and bones. In particular, the long, pointed canine teeth are well developed and are used to kill prey by biting through the back of the neck to sever the spinal cord. They are also formidable weapons if the cat becomes involved in a fight.

The last premolars in the upper jaw and the first molars in the lower jaw are the largest teeth present and are called the 'carnassials'. These have cusps with sharp, cutting edges and work against one another in a scissor-like motion, being used for slicing off and chewing the flesh of the prey animal. The smallest teeth are the six incisors at the front of the jaw between the two canines. These are used for carrying prey (or young kittens by a mother cat) as well as for teasing out small strips of flesh.

Taken from: http://www.healthycatscare.com

**Adaptation Sensation – Student Chart: Cat**

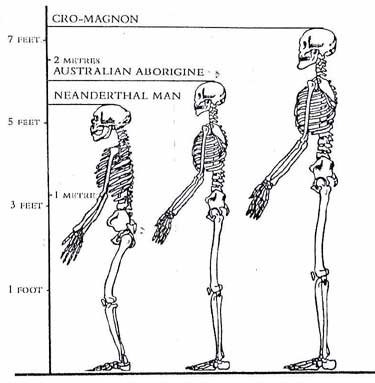
|  |  |  |
| --- | --- | --- |
| **PHYSICAL ATTRIBUTE** | **OBJECT WHICH SERVES AS A METAPHOR (costume)** | **ADAPTATION** |
| Large eyes, dilated pupils |  |  |
| Tapetum lucidum = a layer behind the retina |  |  |
| Large, pointy ears |  |  |
| Highly mobile ears |  |  |
| Special pair of small olfactory organs located near the roof of the mouth, vomeronasal organs or Jacobson's organs |  |  |
| Whiskers, from the cheeks on either side of the nose. Long, stiff, strong hairs |  |  |

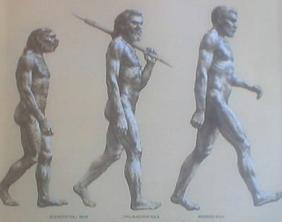
|  |  |  |
| --- | --- | --- |
| **PHYSICAL DESCRIPTION** | **OBJECT WHICH SERVES AS A METAPHOR (costume)** | **ADAPTATION** |
| Sensory hairs along the back of the front legs (the 'carpal hairs'), Like whiskers |  |  |
| claws |  |  |
| tail |  |  |
| Fluid-filled, semicircular canals within the inner ear |  |  |
| Long, pointed canine teeth |  |  |

**Adaptation Sensation – Teacher Key: Cat**

|  |  |  |
| --- | --- | --- |
| PHYSICAL ATTRIBUTE | OBJECT WHICH SERVES AS A METAPHOR (costume) | ADAPTATION |
| Large eyes, dilated pupils | Wide-eyed glasses | Cats hunt at dusk and need to be able to see a night |
| Tapetum lucidum = a layer behind the retina | Glow stick | Creates greenish sheen when lit at night = sharpens image |
| Large, pointy ears | 2 birthday hats | Collect and deflect sound rays inwards towards the eardrum and the organs of hearing |
| Highly mobile ears | Dixie cups on ears | Detect higher frequency wavelengths in the ultrasonic range up to about 65 KHz |
| Special pair of small olfactory organs located near the roof of the mouth, vomeronasal organs or Jacobson's organs | Small plastic nose on headband – place under actual nose | sensitive to chemical odors; scent messages, or pheromones, can tell if males have marked territory |
| Whiskers, from the cheeks on either side of the nose. Long, stiff, strong hairs | Temperature sensitive rulers attached by a headband | associated with sense cells that are very sensitive to touch  whiskers are used by the cat to 'feel-' its surroundings and are particularly useful at night |
| Sensory hairs along the back of the front legs (the 'carpal hairs'), Like whiskers | Temperature sensitive rulers attached by a headband | provide a cat with a highly developed sense of touch |
| claws | 2 pairs of grippy socks (help you get a good grip) 2 on hands and 2 on feet | agile and sure-footed climbers with a highly developed sense of balance.  enable them to obtain a good grip while climbing |
| tail | Blow up barbell with string to tie on backside | used as a counterbalance |
| the fluid-filled, semicircular canals within the inner ear | Hold a balance (air bubble in liquid) | Used to keep in balance |
| the long, pointed canine teeth are well developed | Plastic knife and fork stuck up nostril’s of plastic nose | true carnivore, adapted for killing prey and eating flesh and bones.  used to kill prey by biting through the back of the neck to sever the spinal cord |

**Adaptation Sensation – Humans Now and Then**



**Adaptation Sensation – Student Chart: Human**

* Directions: Examine the pictures carefully.
* Brainstorm ways in which humans have physically changed.
* Write the physical changes in the first column of the chart under “Physical Attribute”.
  + You should have at least 6 changes filled in!
* In the “Adaptation” column (the 3rd column), what purpose this physical attribute serves and how you think it helped humans survive over the years.
* Finally, consider what objects you might use to serve as a metaphor for this adaptation and write it in the 2nd column.

|  |  |  |
| --- | --- | --- |
| **PHYSICAL ATTRIBUTE** | **OBJECT WHICH SERVES AS A METAPHOR (costume)** | **ADAPTATION** |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

|  |  |  |
| --- | --- | --- |
| **PHYSICAL DESCRIPTION** | **OBJECT WHICH SERVES AS A METAPHOR (costume)** | **ADAPTATION** |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |