centre de développement pédagogique
pour la formation générale en science et technologie

Working document

Carnivore, omnivore or herbivore?

Physical adaptations of the giant panda

Student booklet (ST)

October 2010

Context

The Giant Panda is a species that is faced with extinction. It is an animal emblematic of China, the country in which the majority of the individuals living in the wild are found. There are also some in India. Its "teddy-bear" appearance makes it awfully attractive and contributes to its renown.

Every time an animal or vegetal species disappears, the biosphere loses some of its diversity. Though it has not always been the case, society today is more and more sensitive to the future consequences of a reduction in biodiversity. That's why many researchers the world over are carefully studying specific species. These studies allows us to better understand the lifestyle and particularities of these species, in order to effectively target the actions necessary to prevent or improve the situation of the remaining cases.

A local biologist, Mr. Cyrille Barette, has studied the giant panda, of which several aspects defy science. In his study, he compared three bears: the black bear, the sloth bear and the giant panda. These three animals are a part of the Ursidae family, in the Carnivore order of the Mammals class of the Animal kingdom.

His research has allowed us to better understand this animal and the physical and behavioural evolutionary adaptations it has undergone that have led to what it is nowadays.

Today, we suggest that you emulate the task of Cyrille Barette in his role as biologist and that you in turn, study the particular case of the Giant Panda.

Your challenge:

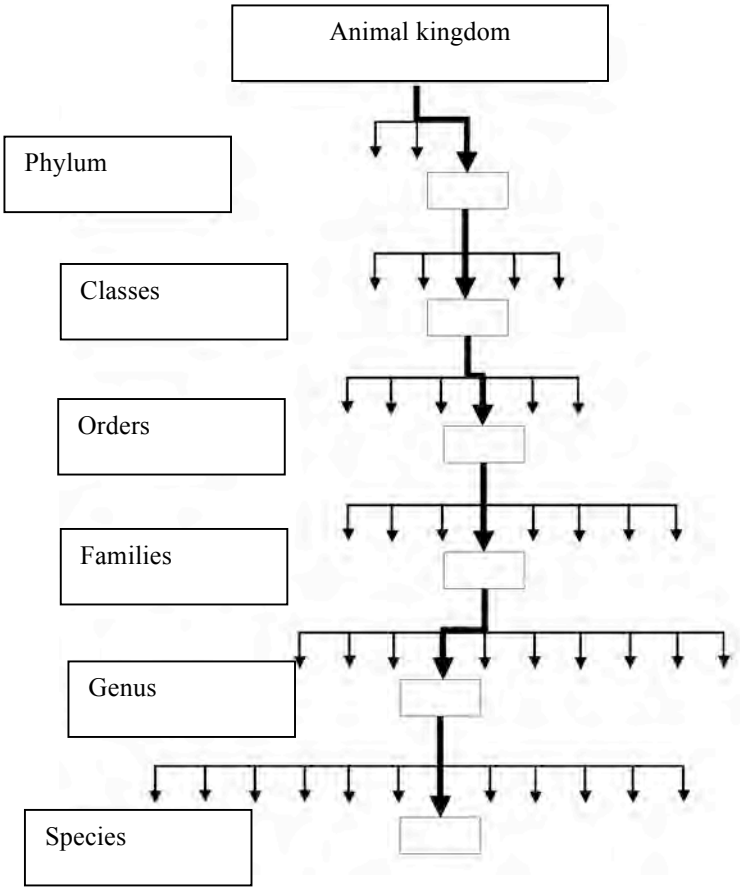
You must repeat Mr. Barette's work regarding jaws, then compare and classify different animals. Finally, you will use your new knowledge to give your opinion on various questions related to ecology.

ACTIVITY 1: Taxonomy or classification

Many animals resemble one another closely. Take bears: some are white, others black or brown. As to birds, some have different beak shapes (long, short, curved, straight, etc.) and short or long wings.

There are hundreds of thousands of species: how do we classify them? How do we differentiate them? What is similar from one species to the next? Why all these differences?

Several animal classifications exist, some from long ago. With advances in science from a genetics point of view, the well known classification system shown below, which divides living beings into five kingdoms, is more appropriate for the identification of animals, than for classification.



In this table, the number of arrows represents, as an indication only, the great diversity of each of the levels. The number at each of the levels varies significantly according to the criteria used to classify them.

Discoveries in genetics have allowed for the establishment of a new method of classification: phylogenetic or cladistic classification. This classification is based on the genetic and evolutionary characteristics of the living. In other words, all animals with a common ancestor are a part of the same cladistic family. Imagine all these animals in a big container. Among these animals, some will have another common ancestor, so we will put them in a smaller container inside the bigger one, and so on.

In order to understand this kind of animal classification better, let's imagine an example using polygons. Now we'll refer to common characteristics, rather than common ancestors.

Example:

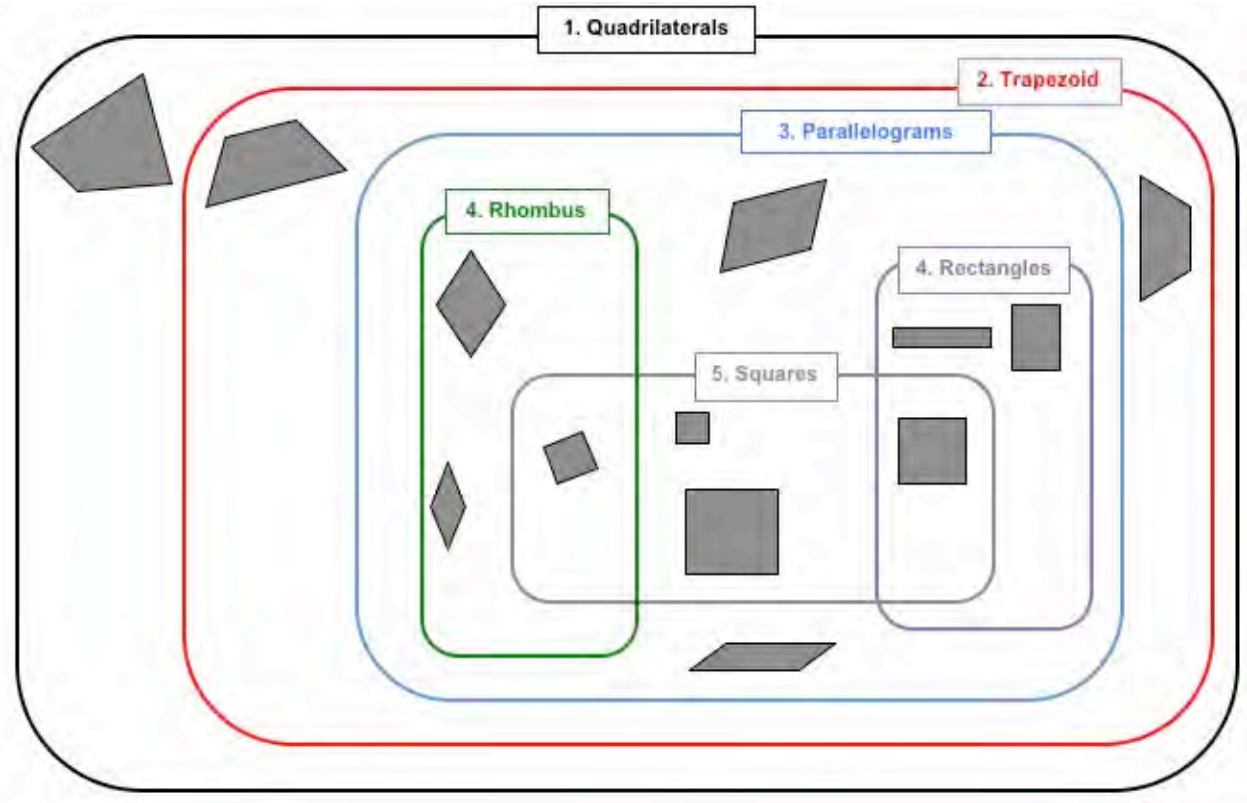
1) Let's take all four sided polygons, which belong to the **quadrilateral** family.

2) By observing the quadrilaterals, we can form a subset of **trapezoids** (a quadrilateral having at least one pair of parallel sides).

3) Among these trapezoids, another common characteristic appears: two pairs of opposite sides are parallel. So, another subset: **parallelograms**.

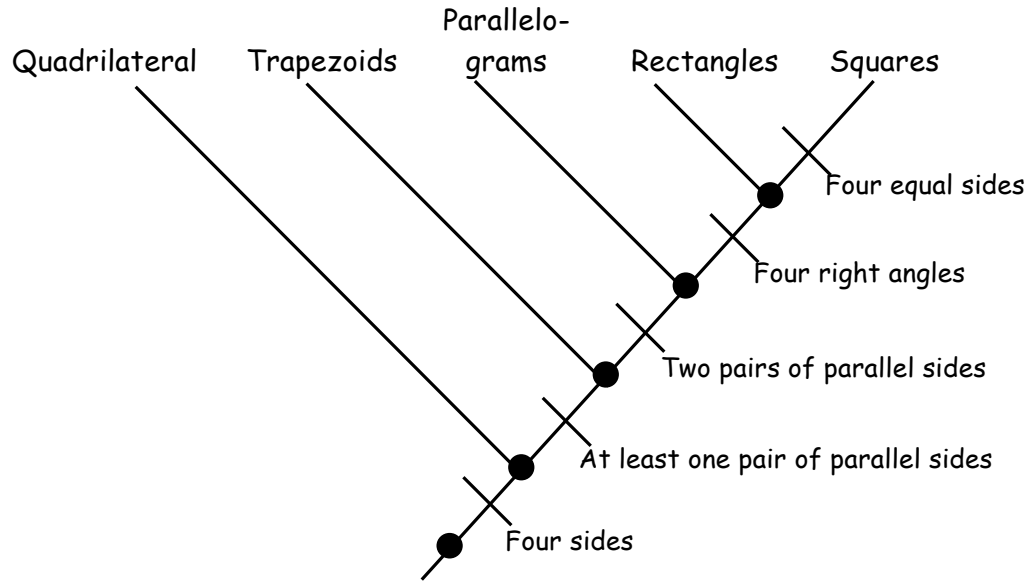
4) Among the latter set, two other common, but distinct characteristics are present: four right angles and opposite sides of the same length. We thus have two other subsets: **rectangles and rhombuses.**

5) A last set fits into both these last subsets: **squares**. In fact, a square is both a rhombus and a rectangle. It has four right angles and its opposite sides are the same length.



** To simplify the example, we will ignore the rhombus set for the purposes of the phylogenetic diagram.*

Here now is the representation of the family of quadrilaterals according to the phylogenetic representation method. This type of diagram is called a **cladogram**.



Now let's go from the mathematical example to a biological application.

Using the supplied labels, you must complete the cladogram on the following page with these words.

Frog	4 feet	Wolf	Biped*
Vertebrae	Trout	Human	Nails*
Teats	Amniotic eggs *	Lizard	Macaque*

Here are a few precisions that will help you complete the task.

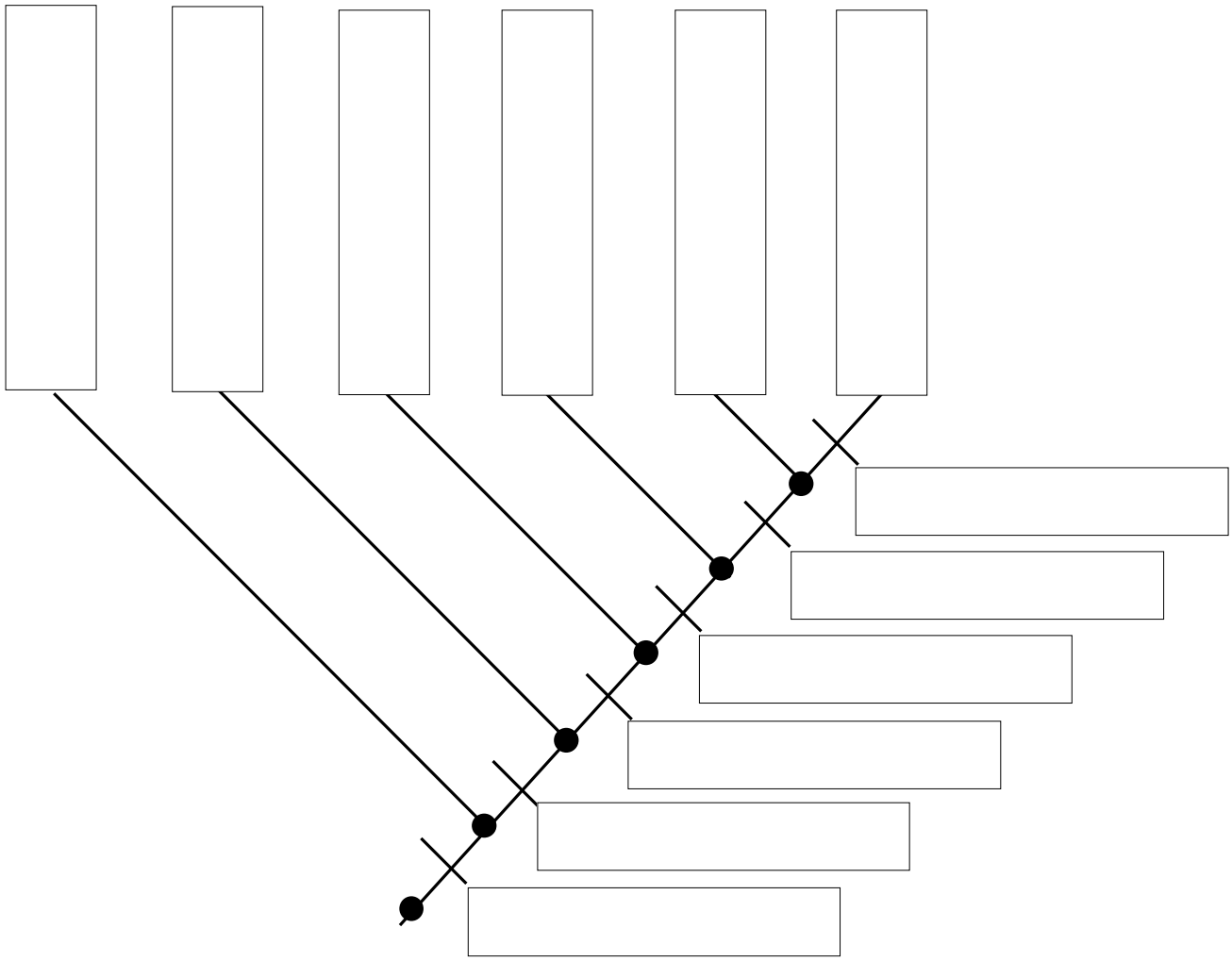
amniotic egg: egg with a semi permeable shell that allows the embryo to develop in a safe, protected place that includes food reserves (starts to appear in reptiles).

nails: only primates and humans have nails. Other animals have claws or hooves.

biped: animal that walks on two feet

macaque: North African monkey

Here is the cladogram to be completed.



ACTIVITY 2: Simple machines: the case of levers

Thousands of years ago, man already used simple machines without really understanding them. Whether it was to lift an enormous boulder, to draw water from a deep well or to move heavy weights over long distances, the principle was present without having been scientifically explained. Today, these inventions are based upon principles related to mechanical physics. There are **a few simple machines:**

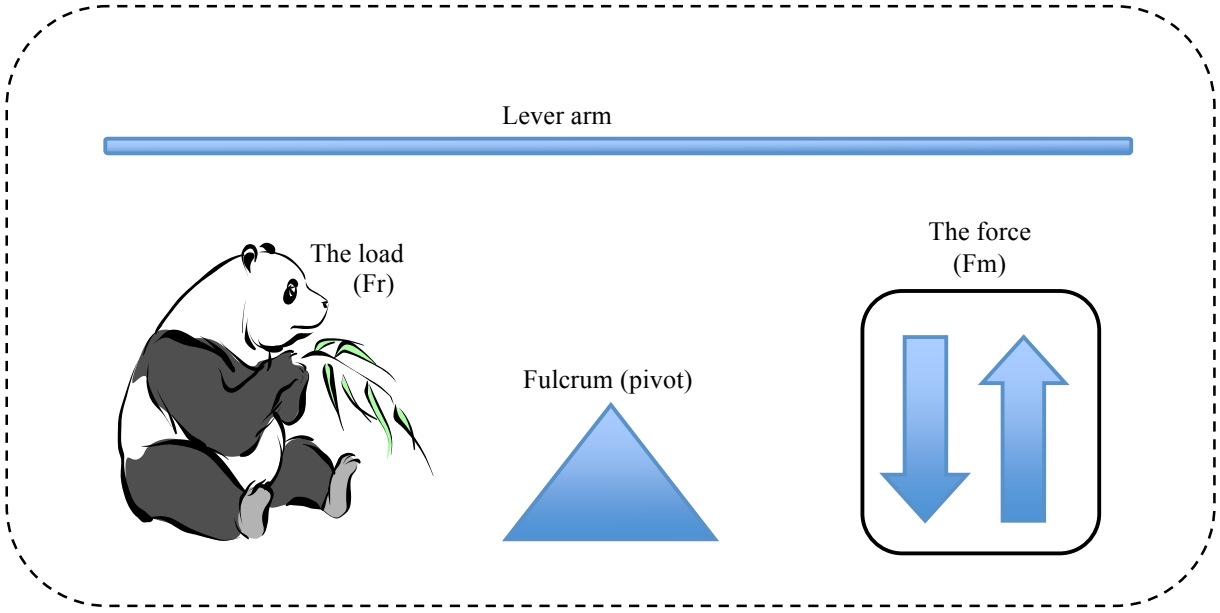
- The lever
- The inclined plane
- The wheel
- Combinations of these, for example: the corner, the screw, etc.

In this task, you will have to work more specifically on types of levers. The lever is a solid bar, mobile around a fixed point, allowing the force applied to a load to be multiplied; often used to lift a heavy burden (translation of an Antidote definition).

Principle of the lever:

There are three parts to a lever. Depending on their position in the set, this means three types of levers.

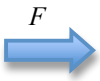
1. The force (Fm): represented by a big arrow
2. The fulcrum (pivot): represented by the triangle
3. The load (resisting force) (Fr): represented by the panda



Now, let's define these parts:

What is **mechanical force**?

Mechanical force is always represented by a big arrow.



It is determined by these characteristics:

- The application point (the location)
- The direction
- The intensity (the amount of force)

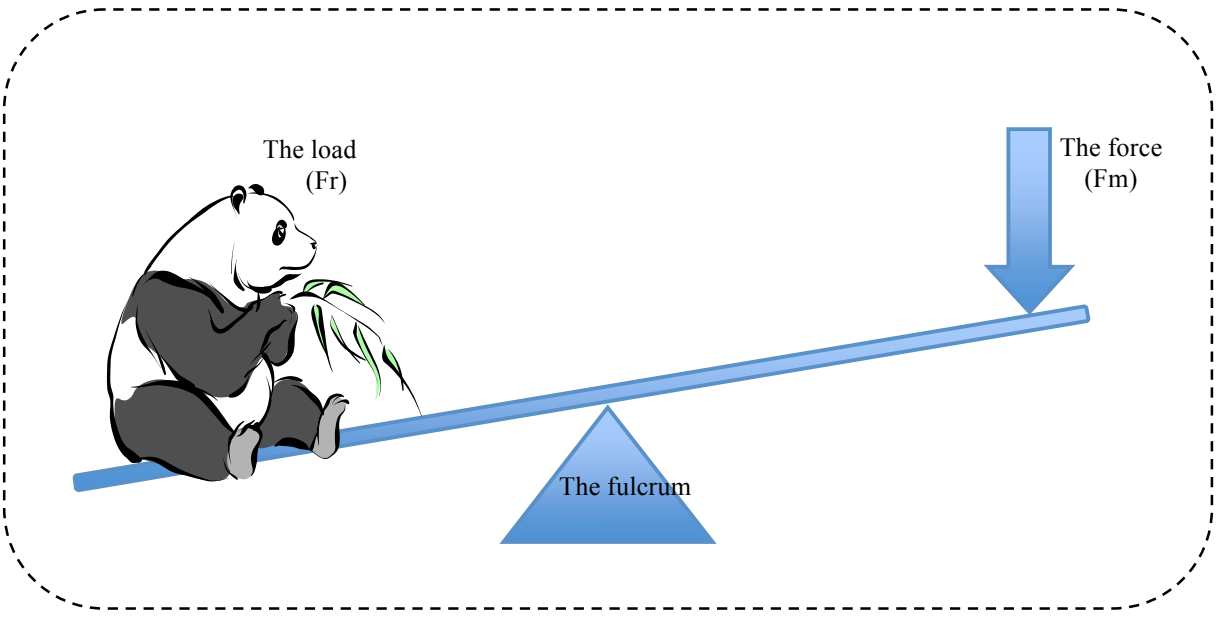
The instrument allowing force to be measured is the dynamometer. The dynamometer gives a measurement in Newton (N).

What is a **fulcrum** (pivot)?

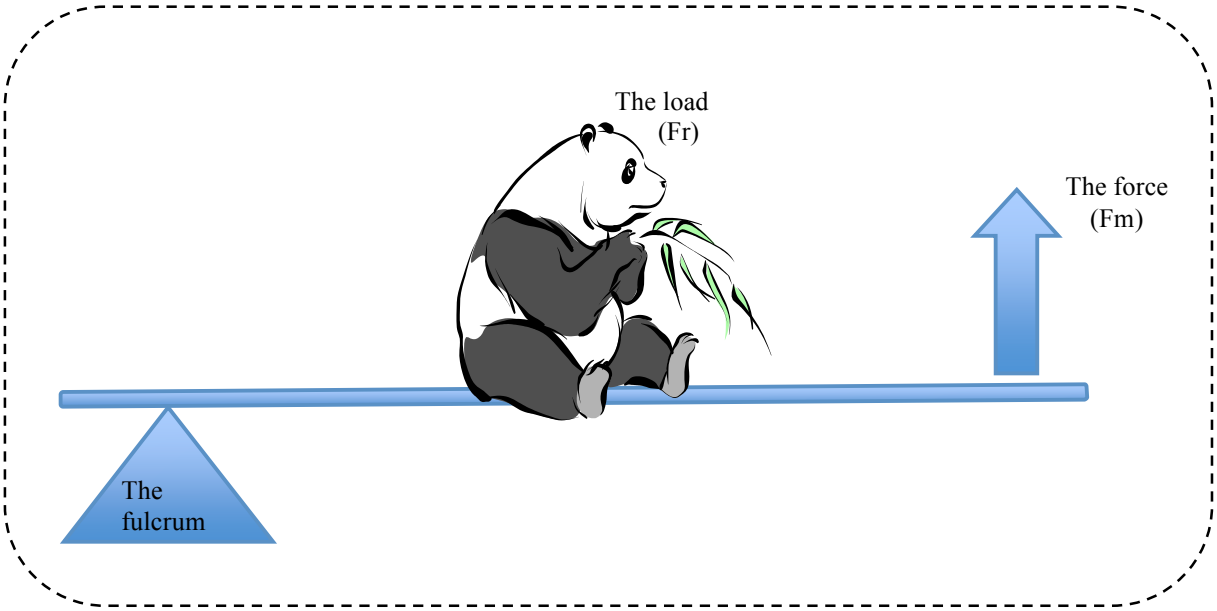
What is the **resisting force** (the load)?

Now, let's see the three categories of levers:

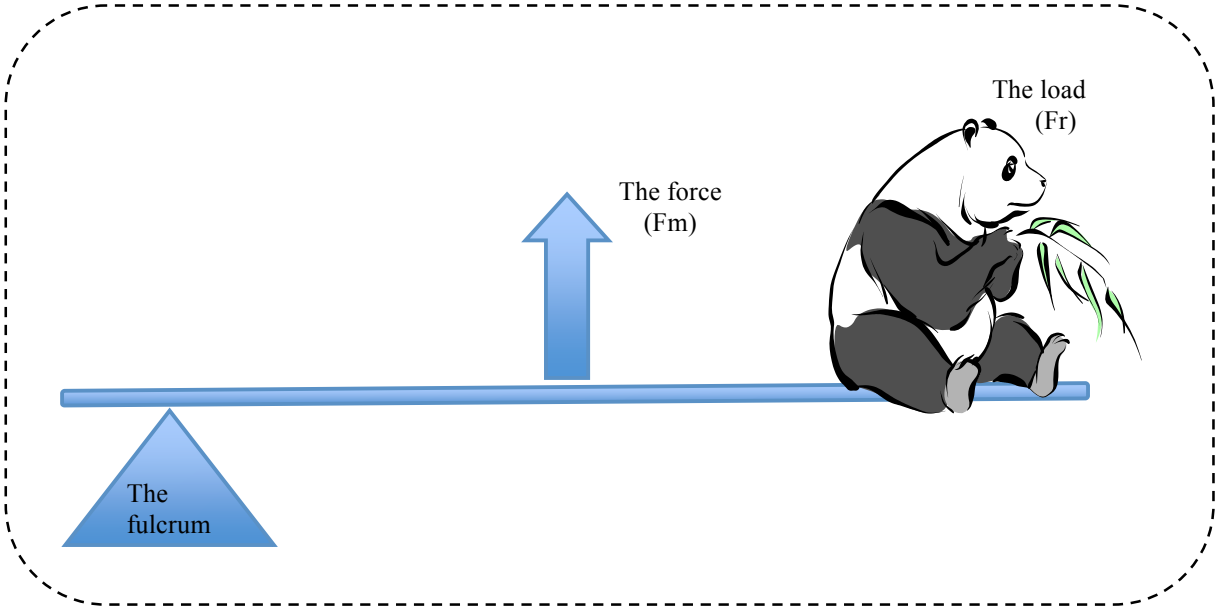
1- Class 1 lever: In this type of lever, the fulcrum is located between the applied force and the load. Examples: tweezers, scissors, teeter-totter.



2- Class 2 lever: In this type of lever, the load is between the applied force and the fulcrum. Examples: wheelbarrow, nutcracker, bottle opener.



3- Class 3 lever: In this type of lever, the applied force is between the load and the fulcrum. Examples: tweezers, moving or lifting a hockey stick, shovel.



MANIPULATIONS AND EXERCISES:

Observe and manipulate the objects at your disposal.

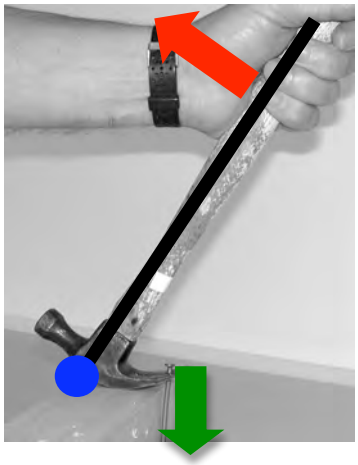
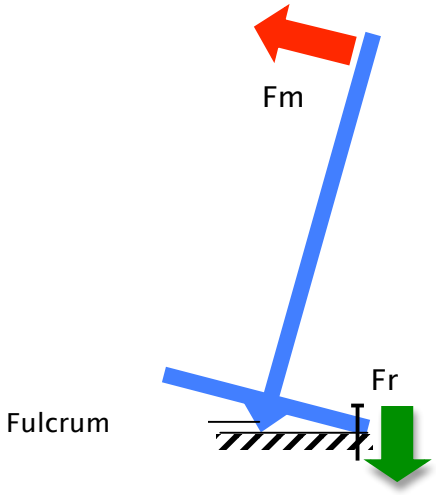
On the image corresponding to the observed object, indicate by:

1. RED ARROW: The location and direction of the force (Fm).
2. GREEN ARROW: The location of the load or resistance (Fr).
3. BLUE CIRCLE: The location of the fulcrum.
4. BLACK LINE: The lever arm.
5. TYPE: Specify the type of lever.

In the right hand column:

1. DRAW a sketch of the object.

Repeat these observations and manipulations for each object.

Object	Diagram
 TYPE:_____ *Class 1 lever*	
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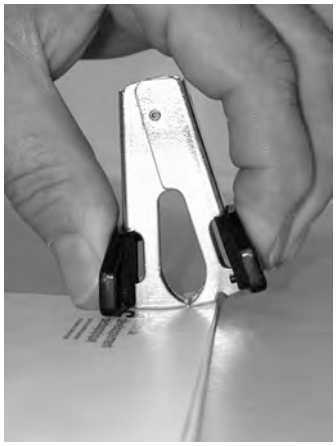
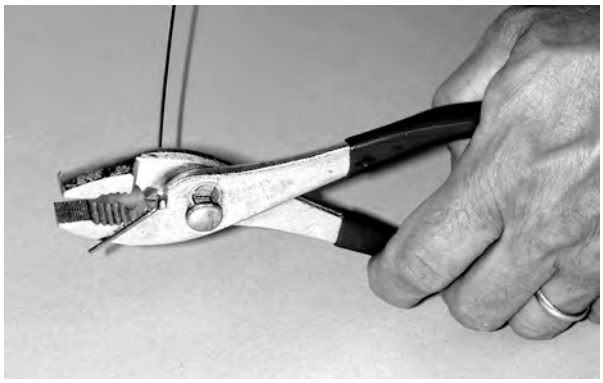
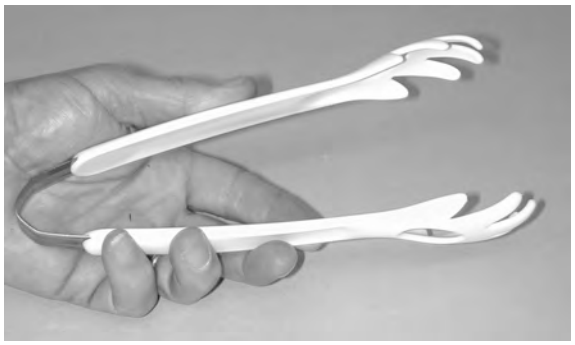
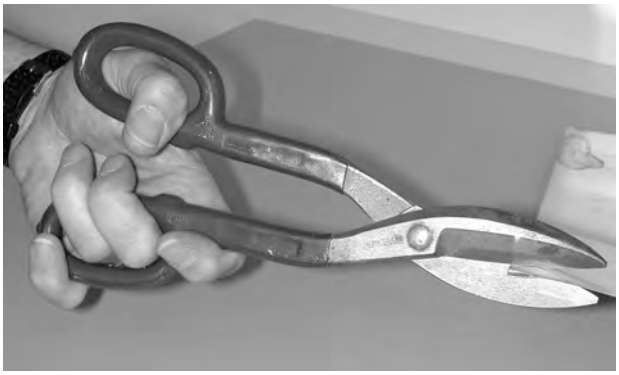
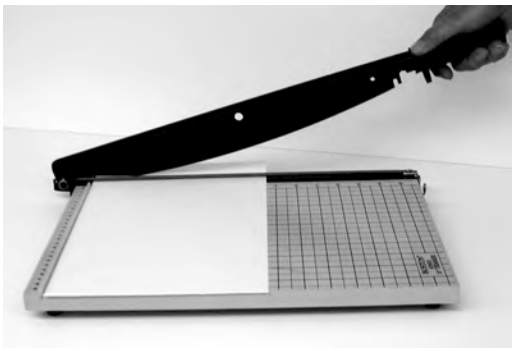
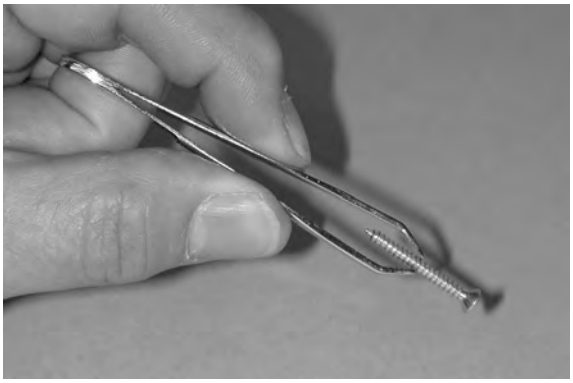
MANIPULATIONS AND EXERCISES (continued):

Object	Diagram
 TYPE:_____	
 TYPE:_____	
 TYPE:_____	

MANIPULATIONS AND EXERCISES (continued):

Object	Diagram
 TYPE:_____	
 TYPE:_____	
 TYPE:_____	

MANIPULATIONS AND EXERCISES (continued):

Object	Diagram
 TYPE:_____	

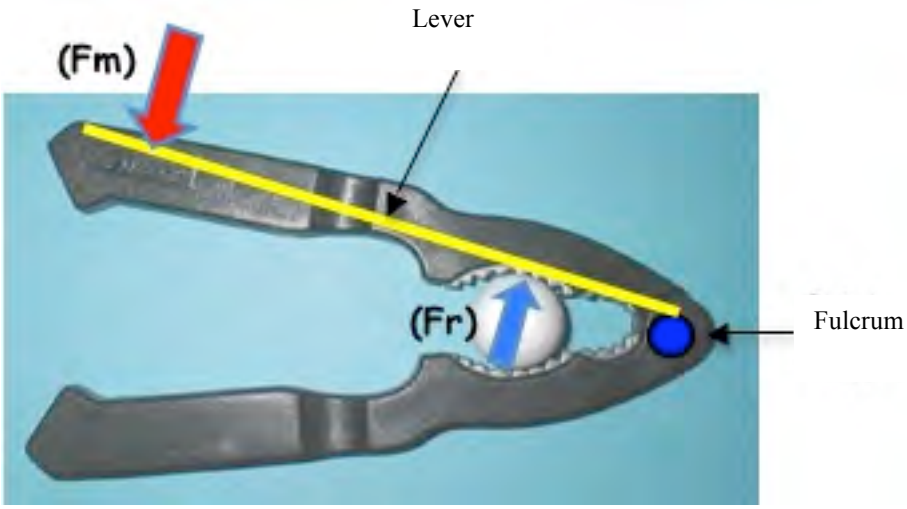
Mechanical advantage

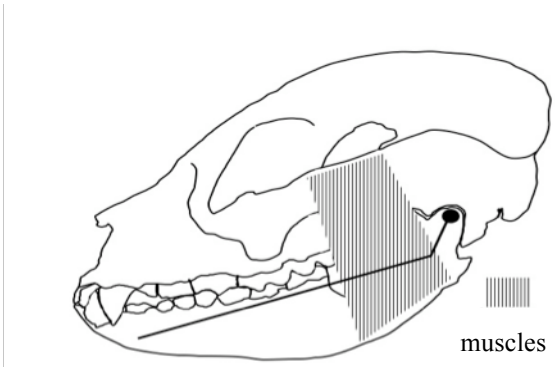
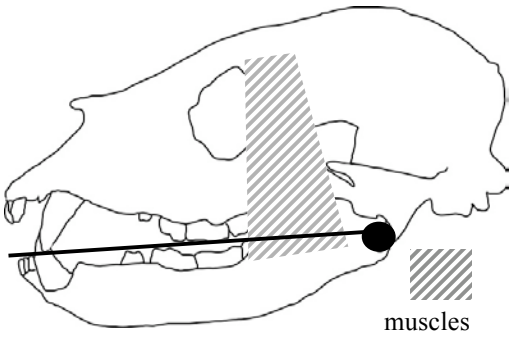
There is said to be a **mechanical advantage** when the applied force necessary is inferior to the load. It is expressed by a number corresponding to the ratio between te two lengths (pivot - motor and pivot - load). If I force four times less than the value of the load, I have a mechanical advantage of four.

Applied force Load Force motrice Résistance Fulcrum (axis of rotation) Appui (axe de rotation)	Example: Class 1 lever Ratio Lm/Lr = 30/10 = 3 Positive advantage Avantage positif
Force motrice Load Applied force Résistance Appui (axe de rot Fulcrum (axis of rotation)	Example: Class 2 lever 10 cm 40 cm Ratio Lm/Lr = 40/10 = 4 Positive advantage
Load Applied force Fulcrum (axis of rotation)	Example: Class 3 lever 20 cm 40 cm Ratio Lm/Lr = 20/40 = 1/2 = 0.5 Negative advantage

ACTIVITY 3: The jaw and its adaptations

In the previous exercise, we explored different types of levers. Here now are the skulls of a panda and a black bear. Indicate, on the skulls, the driving and resisting forces. Inspire yourself from the image of the nutcracker.



Panda	Black bear
	

Name the type of lever for each skull:

Panda: _____ Black bear: _____

Compare the position of the pivot for each jaw. What do you notice?

_____

_____

_____

It is important to underline that ruminants have a herbivorous diet and carry out a side to side grinding movement thanks to the mobility of the mandible. This movement allows the vegetation to be ground, in order to draw from it the maximum in nutritional elements. This movement, combined with their unique digestive system, allows ruminants to extract the energy necessary to their activities. The panda can not execute this movement and does not possess the digestive system of a ruminant. As to "carnivores", or rather animals that have a carnivorous diet, they draw their energy from the consumption of protein and energy rich meats. The term "carnivore" is often confused with the order of Carnivores.

The particularity of the panda's jaw is that it can crush and grind the food simultaneously as it closes its mouth. It is thanks to the position of the pivot of its jaw (higher than its teeth) that it can perform the two actions in a single movement. In addition, it has very big teeth (four times bigger than the black bear's). Given the large surface of its teeth, it can crush a great quantity of food. These particularities are what we call the "adaptations".

There are **physical adaptations** that can be determined by the climate (thickness of the fat layer or fur), food (type of beak or teeth), the season (colour of pelt), etc.

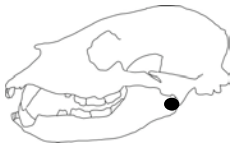
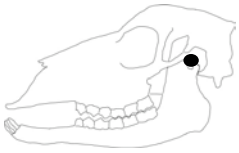
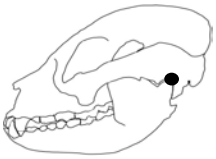
There are also **behavioural adaptations** that allow for a social life within the group of individuals (e.g.: there is a dominant male in a wolf pack).

We will concentrate our comparative study on the adaptation related to diet, namely on the types of teeth present depending on the species.

Comparative study on adaptations linked to diet (types of teeth according to food)

Using the images of the skulls, build a data table allowing you to compare and classify the animals.

Here are some key words that could help you build your table:
type of teeth - number of teeth – surface of the teeth – mechanical function of the teeth– animal's diet (what it eats).

Black bear 	
Deer 	
Beaver 	
Wolf 	
Panda 	

Given the data you have compiled, you should be able to classify these animals. What groupings will you make?

What criteria did you use to make this classification?

Suppose we group the wolf, black bear and panda into a single set. What would the classifying criteria be?

ACTIVITY 4 : Taxonomy

Complete the following table using the documentation supplied.

	Giant panda	Black bear
Phylum	Chordates	Chordates
Sub-phylum	Vertebrates	Vertebrates
Class		
Order		
Sub-order		
Family		
Genus		
Species		

1. Describe the habitat of the giant panda and of the black bear.

2. What does the giant panda eat?

3. What does the black bear eat?

4. If a change takes place in their respective habitats, for instance a type of vegetation disappears, which of the two bears has a better chance of survival? Explain your answer.