



# Carnivore, omnivore or herbivore?

## Physical adaptations of the giant panda



**ST**



**ATS**

**Animator's document  
(Teacher's document)**

**ST - AST**

June 2010

## Introduction

This activity was designed within the framework of training sessions for personnel in science and technology. It is an example of a learning and evaluation situation (LES) designed for the 1<sup>st</sup> cycle of secondary school. It nonetheless allows for the introduction of the differentiated streaming - general stream and general applied stream - that is found in the 2<sup>nd</sup> cycle of secondary school.

Since students must make a choice of streams starting in the third year of high school, the learning situations used as early as the 1<sup>st</sup> cycle can allow the student to better target the training profile that suits them best in science and technology. Though this LES allows the student to choose one or other of the contexts, it is neither necessary nor even suggested to do so for all the LES used in the course of the cycle. It may, however, be useful and helpful for the students to know to which stream an LES is tied. It will allow them to make a more informed choice at the given time.

This activity was inspired by a conference given in the fall of 2009 by Mr. Cyrille Barette, a biologist from here and a retired professor at the University of Laval, within the framework of an APSQ congress. (Association for the teaching of science and technology in Quebec) The subject of his study allows for the effective integration of concepts from the technological and living worlds.

In fact, Mr. Barette studied the case of the giant panda by comparing it to its close relatives according to the phylogenetic classification. His research allows for better understanding of this animal and of the physical and behavioural evolutionary adaptations that brought it to where it is today. Indeed, while its genetic and physical characteristics make it an omnivore like the black bear, the panda's diet and behaviour are closer to an herbivore's.

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 to grind food and crush it as he closes his mouth. It is thanks to the position of the pivot of the jaws (higher than the teeth) that it can perform these two actions in a single movement. In addition, the panda has very big teeth (four times bigger than those of the black bear). Given the large surface of its teeth, it can crush an enormous quantity of food. These particularities are part of what is called the "adaptations".

⇒ **Note to the teacher:** It is suggested to place the students in teams and to leave them ten minutes or so at the end of activities 1 and 4, in order that they might share the information gathered and so that all of them become aware of the distinction between the two proposed streams.

## Outline of the « Carnivore or herbivore! » LES

**NOTE :** This activity was designed within the framework of training sessions. It may require adaptation before being used with students.

PREPARATION	
	<b>1</b> Trigger <ul style="list-style-type: none"> <li>• Context</li> </ul>
	<b>2</b> Activation of previous knowledge <ul style="list-style-type: none"> <li>• Context</li> </ul>
REALISATION AND INTEGRATION	
	<b>3</b> Learning activities <p style="text-align: center;">ST STREAM</p> Activity 1: <ul style="list-style-type: none"> <li>• Taxonomy or classification (cladogram)</li> </ul> Activity 2: <ul style="list-style-type: none"> <li>• Simple machines (levers)</li> </ul> Activity 3 : <ul style="list-style-type: none"> <li>• The jaw and its adaptations</li> </ul>
	<b>4</b> Establishing a plan <p style="text-align: center;">AST STREAM</p> Activity 1: <ul style="list-style-type: none"> <li>• Analysis of objects and jaws</li> </ul> Activity 2: <ul style="list-style-type: none"> <li>• Simple machines (levers)</li> </ul> Activity 3: <ul style="list-style-type: none"> <li>• The jaw and levers</li> </ul>
	<b>5</b> Complex task <ul style="list-style-type: none"> <li>• Comparative study on the adaptation linked to diet - ST</li> <li>• The jaw and diet - AST</li> </ul>
	<b>6</b> Synthesis activity <ul style="list-style-type: none"> <li>• Taxonomy - ST</li> <li>• Opinion building process- ST</li> <li>• Analysis and modeling process - AST</li> </ul>

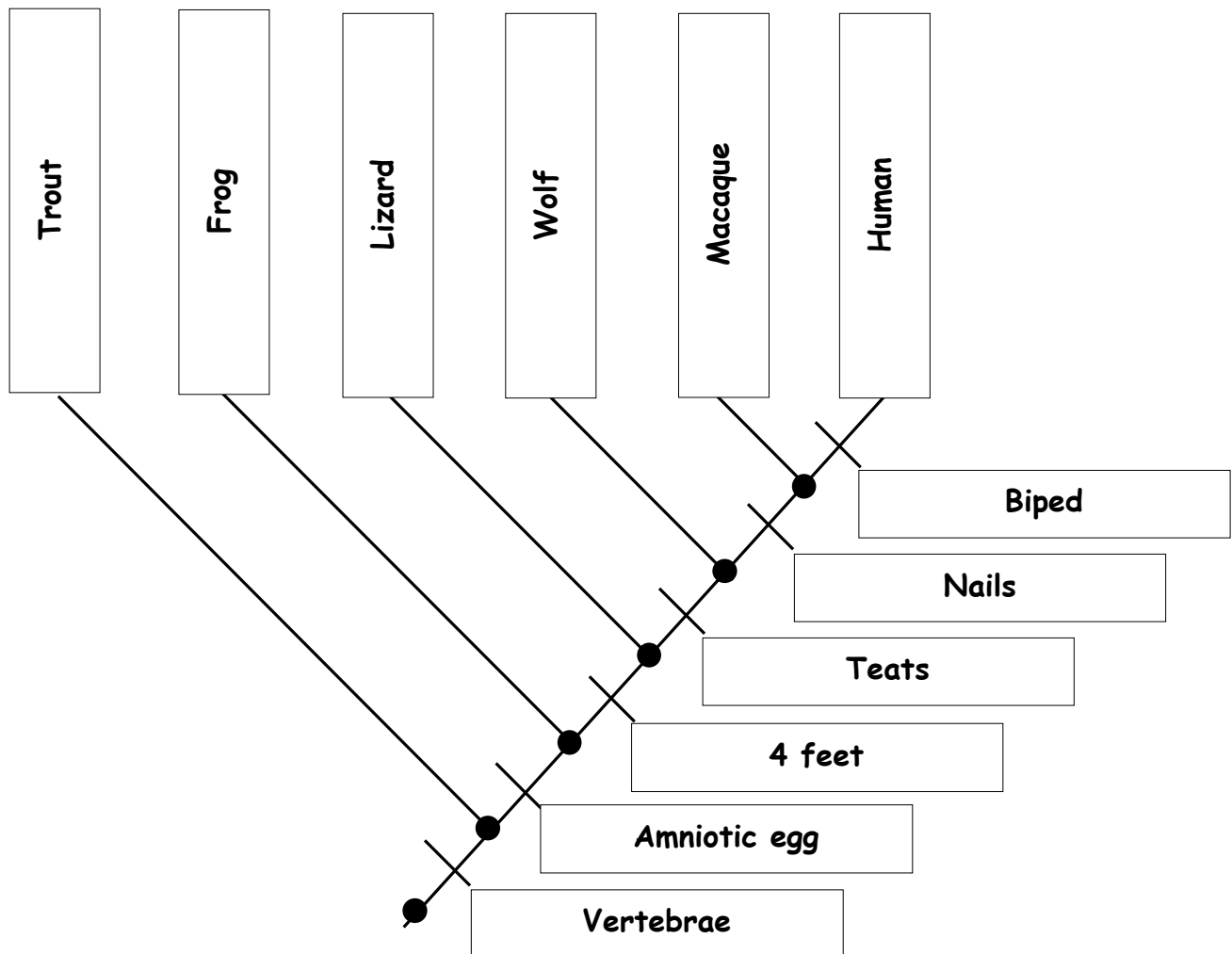
⇒ **Note to the teacher:** the pictograms used in this table and throughout the LES are presented in Annex 1 of this document. It is important that the students become familiar with them. They are used again in the student booklet and will also be used in other LES.



## ACTIVITY 1 Taxonomy or classification

Answers expected in the student booklet– page 6 - ST

Cladogram to be completed:



⇒ Note to the teacher: The "empty" cladogram and the words to be used are presented in Annex 2 and 3 of this document. They may be plasticized for ease of use (adding a self adhesive "Velcro" fastener to the words is feasible). This way the student can easily make more than one try. He may also work with an erasable pen on a plasticized version.

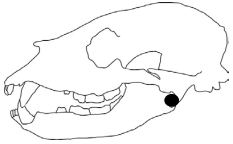
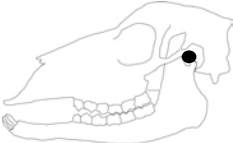

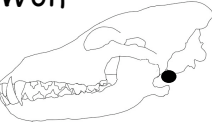
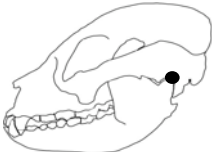
⇒ For students who have difficulty with the mathematical definitions, an alternative, using toys, is suggested.



## ACTIVITY 1: Analysis of objects and jaws

Answers expected in the student booklet – page 4 - AST

SKULLS COMPARISON TABLE

Animal skull	What type of teeth are there?	What is their mechanical function?	Location of the rotation point (pivot)	Number of teeth	Diet
Black bear 	A- Incisor B- Canine C- Molar	Crush C Cut/grate A Shred/slice X	<input type="checkbox"/> Far above the upper teeth <input type="checkbox"/> A bit above the upper teeth <input checked="" type="checkbox"/> At the same level as the upper teeth	42	<input type="checkbox"/> carnivore <input type="checkbox"/> herbivore <input type="checkbox"/> insectivore <input checked="" type="checkbox"/> omnivore
Deer 	A- Incisor B- Canine C- Molar	Crush C Cut/grate A Shred/slice X	<input checked="" type="checkbox"/> Far above the upper teeth <input type="checkbox"/> A bit above the upper teeth <input type="checkbox"/> At the same level as the upper teeth	32 including 12 on the maxilla	<input type="checkbox"/> carnivore <input checked="" type="checkbox"/> herbivore <input type="checkbox"/> insectivore <input type="checkbox"/> omnivore
Beaver 	A- Incisor B- Canine C- Molar	Crush C Cut/grate A Shred/slice X	<input checked="" type="checkbox"/> Far above the upper teeth <input type="checkbox"/> A bit above the upper teeth <input type="checkbox"/> At the same level as the upper teeth	20	<input type="checkbox"/> carnivore <input checked="" type="checkbox"/> herbivore <input type="checkbox"/> insectivore <input type="checkbox"/> omnivore
Wolf 	A- Incisor B- Canine C- Molar	Crush C Cut/grate A Shred/slice B	<input type="checkbox"/> Far above the upper teeth <input checked="" type="checkbox"/> A bit above the upper teeth <input type="checkbox"/> At the same level as the upper teeth	Sup 28 to 32 Inf 30 to 40	<input checked="" type="checkbox"/> carnivore <input type="checkbox"/> herbivore <input type="checkbox"/> insectivore <input type="checkbox"/> omnivore
Panda 	A- Incisor B- Canine C- Molar	Crush C Cut/grate A Shred/slice B	<input checked="" type="checkbox"/> Far above the upper teeth <input checked="" type="checkbox"/> A bit above the upper teeth <input type="checkbox"/> At the same level as the upper teeth	40	<input type="checkbox"/> carnivore <input checked="" type="checkbox"/> herbivore <input type="checkbox"/> insectivore <input type="checkbox"/> omnivore



## ACTIVITY 1: Analysis of objects and jaws (continued)

### Answers expected in the student booklet – page 5 - AST

**Question 2. Is there a link between the dentition of the observed animals and their diet? Explain your answer.**

There is a link between diet and dentition in animals. They are noticed in:

- Herbivores (deer, beaver): Absence of canines. Incisors used to shred and molars to grind vegetation.
- Carnivores (black bear, wolf, panda) : Presence of canines to shred and slice in order to remove meat from the bones; Incisors to cut and molars not as developed as the herbivores.
- Omnivore (black bear) : Presence of all three types of teeth allowing a wide diet.
- Herbivore (panda) : Similar to the black bear with well developed molars to grind vegetation.

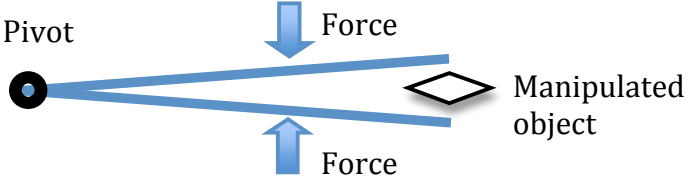
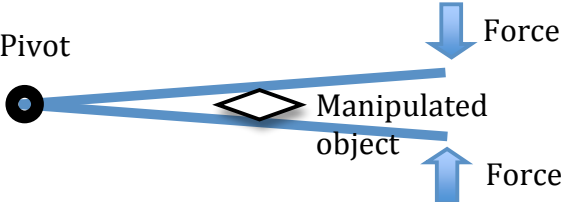
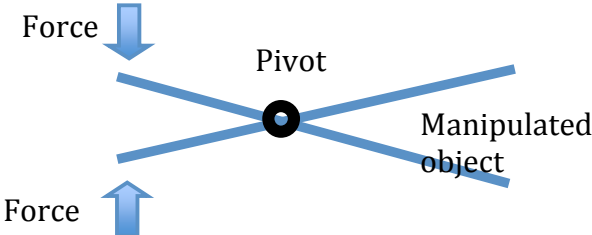
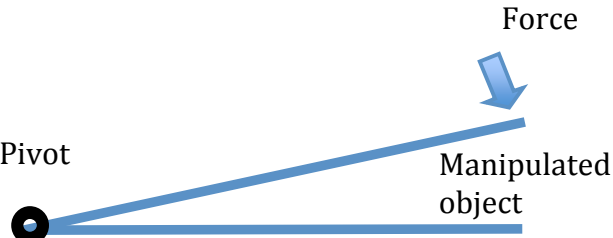
**Question 3. Observe the position of the pivot of the jaw in each of the skulls. Is there a link between the position of the pivot and the diet of each of the animals represented in the table? Explain your answer.**

In herbivores, the position of the pivot of the jaw is markedly above the upper teeth. In omnivores, it can vary, but it is generally slightly above the upper teeth. In carnivores, the position of the pivot is located at the same level as the upper teeth.

⇒ **Note to the teacher: Here is an occasion to explain the distinction between the order of Carnivores, where there are animals that have a diet that is omnivorous, insectivorous, carnivorous or other, and the term "carnivore", often used to designate the diet of certain animals. There is no herbivorous or omnivorous order.**

**Answers expected in the student booklet – page 6 - AST**

**COMMON TOOLS VERSUS JAWS COMPARISON TABLE**

Name of common tool	Part that could be similar to the mandible	Part that could be similar to the maxilla	Part similar to the mandible joint (pivot)	Make a sketch indicating the location of the force that must be applied on the tool; the place where the rotation (pivot) occurs, as well as the location of the object manipulated by the tool.
Example: tweezers	One of the two pinchers	One of the two pinchers	Junction between the two pinchers	 <p>Pivot</p> <p>Force</p> <p>Force</p> <p>Manipulated object</p>
Nutcracker	<u>One of the two pinchers</u>	<u>One of the two pinchers</u>	<u>The pivot</u>	 <p>Pivot</p> <p>Force</p> <p>Force</p> <p>Manipulated object</p>
Scissors	<u>One of the two blades</u>	<u>One of the two blades</u>	<u>The pivot</u>	 <p>Force</p> <p>Force</p> <p>Pivot</p> <p>Manipulated object</p>
Paper stapler	<u>The lever, and the stapler is held upside down</u>	<u>The inferior part, and the stapler is held upside down</u>	<u>The pivot</u>	 <p>Pivot</p> <p>Force</p> <p>Manipulated object</p>



## Answers expected in the student booklet – page 8 - ST - AST

### Now, let's define these parts:

What is **mechanical force**?

Mechanical force is the action of making an object move; to modify the speed or trajectory of an object or the action of distorting an object.

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

A fixed point around which a lever carries out a movement.

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

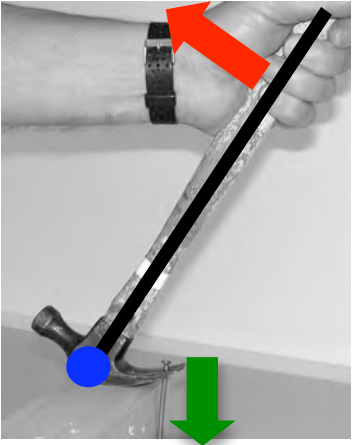
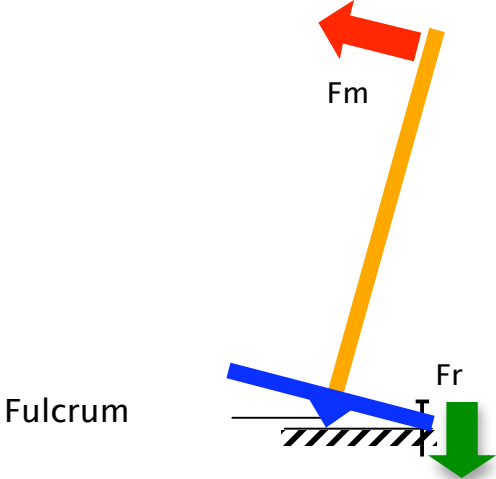
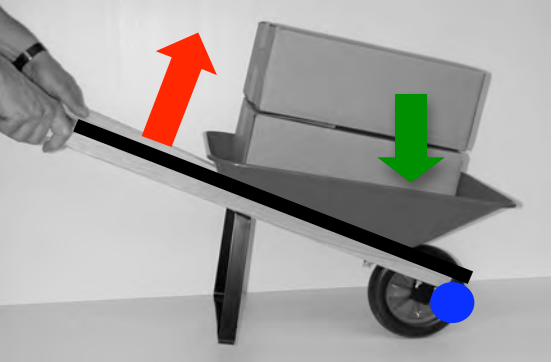
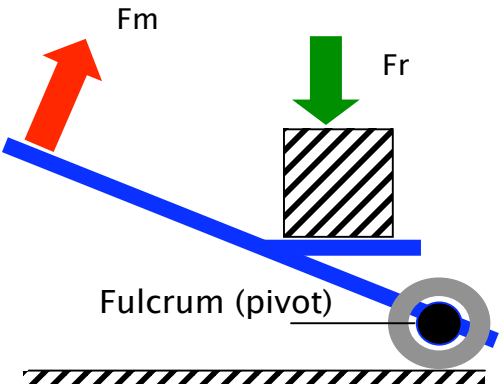
A force that opposes a movement.

**Answers expected in the student booklet – pages 10 to 13**

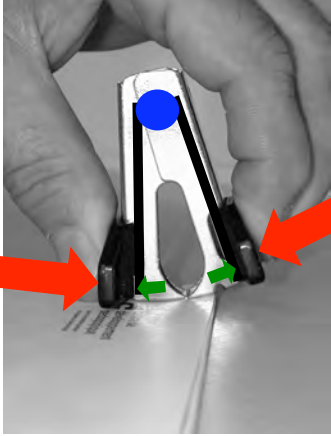
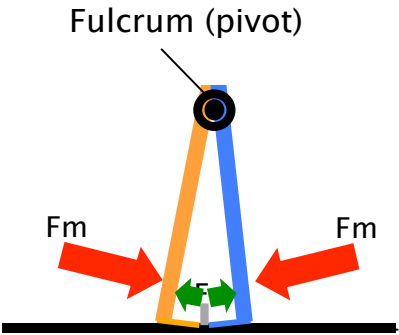
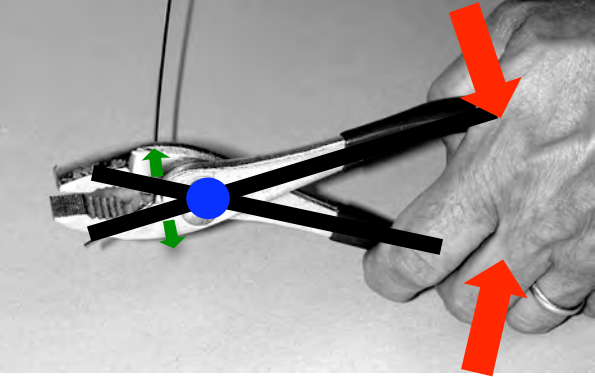
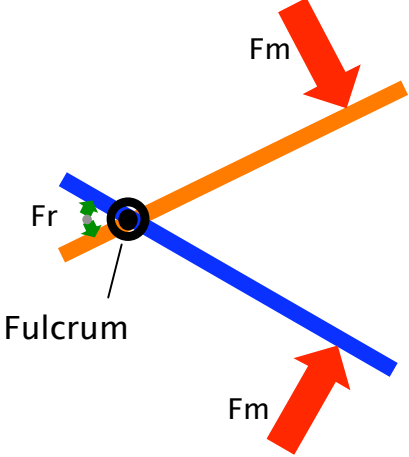
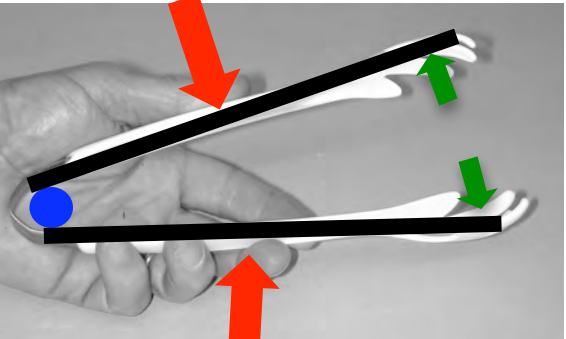
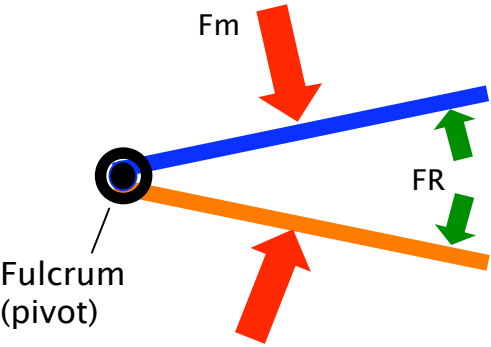
**ACTIVITY 2 : Simple machines, the case of levers**

**MANIPULATIONS AND EXERCISES:**

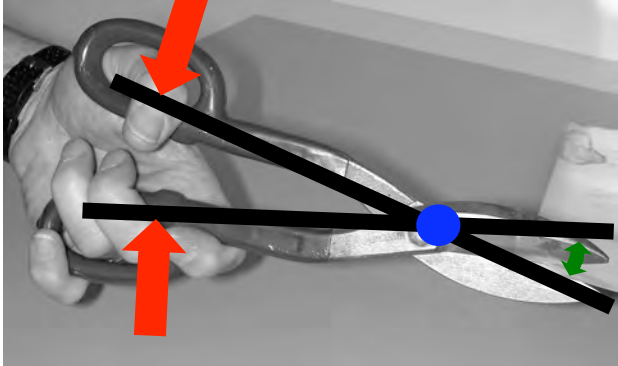
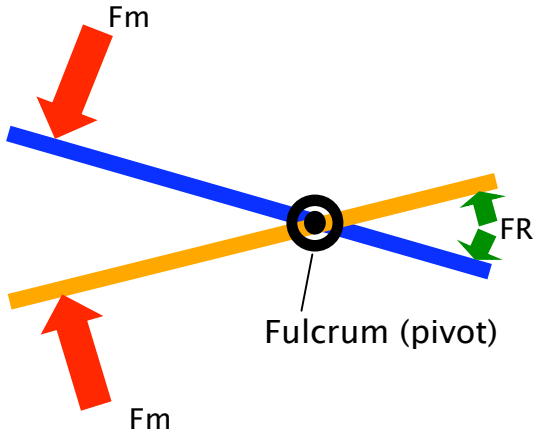
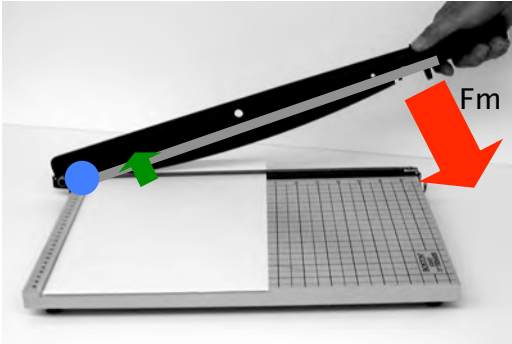
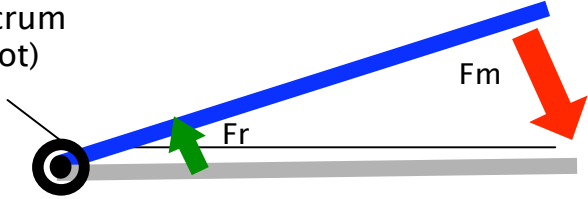
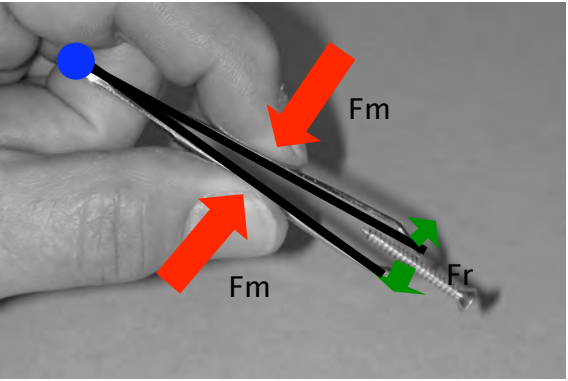
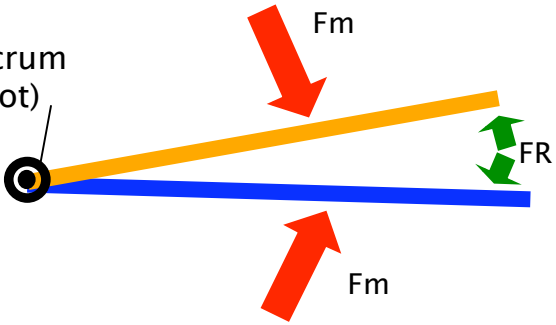
⇒ Note to the teacher: When doing a diagram, it is important to respect certain points: identify each part, use a different colour for each part, etc. This exercise is an excellent occasion to introduce these concepts.

Object	Diagram
 <p>TYPE: <u>Class 1 lever</u></p>	 <p>Fulcrum</p>
 <p>TYPE: <u>Class 2 lever</u></p>	 <p>Fulcrum (pivot)</p>

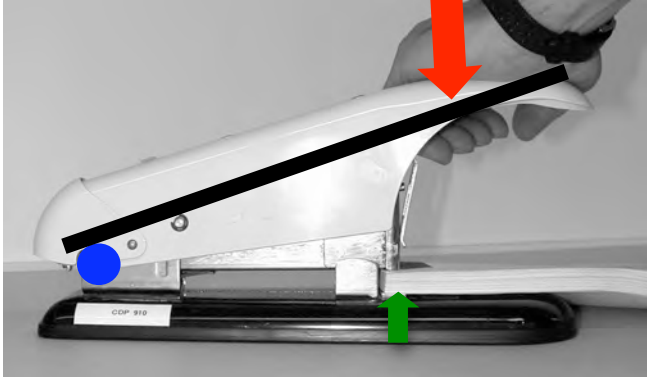
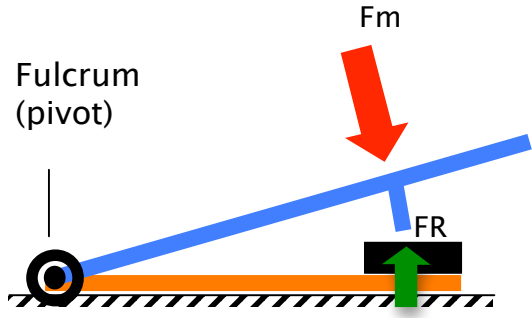
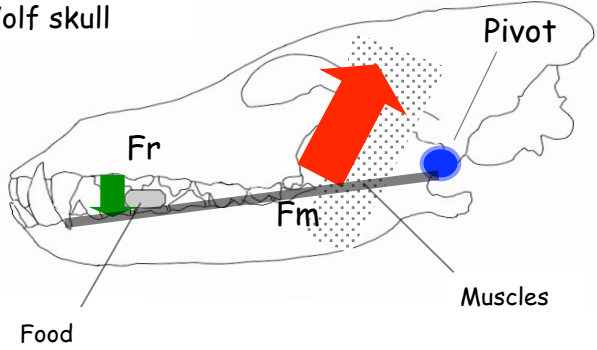
**Answers expected in the student booklet – page 11**

Object	Diagram
 <p>TYPE: <u>Class 3 lever</u></p>	
 <p>TYPE: <u>Class 1 lever</u></p>	
 <p>TYPE: <u>Class 3 lever</u></p>	

**Answers expected in the student booklet – page 12**

Object	Diagram
 <p>TYPE : <u>Class 1 lever</u></p>	
 <p>TYPE : <u>Class 2 lever</u></p>	
 <p>TYPE : <u>Class 3 lever</u></p>	

**Answers expected in the student booklet – page 13**

Object	Diagram
 <p>TYPE : <u>Class 2 lever</u></p>	
<p>AST (only)</p> <p>TYPE : <u>Class 3 lever</u></p> <p>Wolf skull</p> 	<p>It is not necessary to make a sketch. Simply indicate the driving force, the load, and the lever arm and identify the pivot.</p>

**Answers expected in the student booklet – page 14 – AST**

Among the objects previously observed, which would you choose to explain the similarities with the jaw?

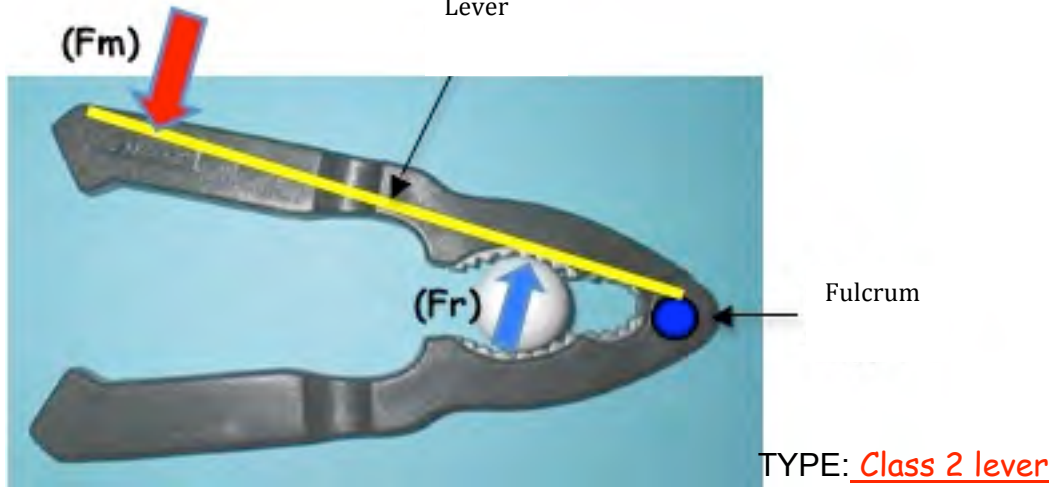
The student should have chosen an object having a class 3 lever.

**Answers expected in the student booklet – page 14 - ST**



**ACTIVITY 3: The jaw and adaptations**

Lever



Panda	Black bear

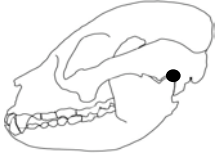




Name the type of lever for each skull:

Panda: Class 3 lever

Black bear: Class 3 lever

Compare the position of the pivot for each jaw. What do you notice? The pivot of the panda's jaw is much higher than the tooth line, while the black bear's is even with the tooth line.

**Answers expected in the student booklet – page 16 - ST**

Animal skull	What type of teeth are there?	Number of teeth	Surface des dents	What is their mechanical function?	Diet
<b>Panda</b> 	<b>A- Incisor</b> <b>B- Canine</b> <b>C- Molar</b>	40	Surface of teeth 4 times bigger than black bear's	Crush C Cut/grate A Shred/slice B	<input type="checkbox"/> carnivore <input checked="" type="checkbox"/> herbivore <input type="checkbox"/> insectivore <input type="checkbox"/> omnivore
<b>Black bear</b> 	<b>A- Incisor</b> <b>B- Canine</b> <b>C- Molar</b>	42	Combination of three types of teeth to allow crushing, cutting and slicing. Has carnivorous teeth	Crush C Cut/grate A Shred/slice B	<input type="checkbox"/> carnivore <input type="checkbox"/> herbivore <input type="checkbox"/> insectivore <input checked="" type="checkbox"/> omnivore
<b>Wolf</b> 	<b>A- Incisor</b> <b>B- Canine</b> <b>C- Molar</b>	Sup 28 to 32 Inf 30 to 40	Combination of three types of teeth to allow crushing, cutting and slicing. Has carnivorous teeth	Crush C Cut/grate A Shred/slice B	<input checked="" type="checkbox"/> carnivore <input type="checkbox"/> herbivore <input type="checkbox"/> insectivore <input type="checkbox"/> omnivore
<b>Deer</b> 	<b>A- Incisor</b> <b>B- Canine</b> <b>C- Molar</b>	32 including 12 on the upper maxilla	Does not have canines. Molars are flattened to offer a surface for crushing (shredding).	Crush C Cut/grate A Shred/slice X	<input type="checkbox"/> carnivore <input checked="" type="checkbox"/> herbivore <input type="checkbox"/> insectivore <input type="checkbox"/> omnivore
<b>Beaver</b> 	<b>A- Incisor</b> <b>B- Canine</b> <b>C- Molar</b>	20	Very long incisors to allow for gnawing branches and tree trunks. Flat molars for crushing (shredding)	Crush C Cut/grate A Shred/slice X	<input type="checkbox"/> carnivore <input checked="" type="checkbox"/> herbivore <input type="checkbox"/> insectivore <input type="checkbox"/> omnivore

## Answers expected in the student booklet – page 17 - ST

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

The student should be able to make the following classifications:

- Herbivore: The deer and the beaver.
- Carnivore: The panda, the black bear and the wolf.

It is possible that the student classifies the black bear as an omnivore and the panda as an herbivore (depending on his personal knowledge).

What criteria did you use to make this classification?

The type of teeth and their role.

Let's suppose we group the wolf, the bear and the panda in the same set. What would the classification criteria have been?

The type of teeth and their role, the position of the pivot of the jaw.

## Answers expected in the student booklet – page 18 - ST

	<u>Giant panda</u>	<u>Black bear</u>
Phylum	Chordates	Chordates
Sub-phylum	Vertebrates	Vertebrates
Class	<u>Mammals</u>	<u>Mammals</u>
Order	<u>Carnivores</u>	<u>Carnivores</u>
Sub-order	<u>Fissipedia</u>	<u>Caniformia</u>
Family	<u>Ursidae</u>	<u>Ursidae</u>
Genus	<u>Ailuropoda</u>	<u>Ursus</u>
Species	<u>Melanoleuca</u>	<u>Americanus</u>



## **Answers expected in the student booklet – page 18 (continued) - ST**

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

Giant panda: Wooded mountains with undergrowth of bamboo in the center of China and oriental Tibet.

Black bear: Continental North American (U.S., Canada)  
- dense forests (mixed coniferous and deciduous forest)

2. What does the giant panda eat?

It is omnivorous, but mainly herbivorous, it eats bamboo almost exclusively.

## **Answers expected in the student booklet – page 19 - ST**

3. What does the black bear eat?

It is omnivorous: it eats plants, fruit, ants, fish, nuts, leaves, grasshoppers, small mammals, birds, carrion and honey.

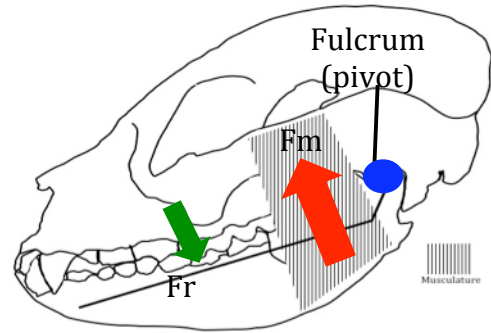
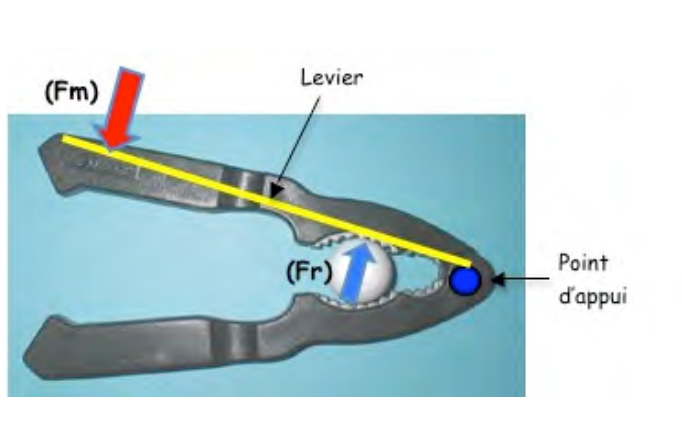
4. If a change takes place in their respective habitats, for instance a type of vegetation disappears, which of the two bears has a better chance of survival? Explain your answer.

The bear should have the better chance of adapting to the changes because its diet is much more varied. It eats whatever is abundant at any given time. The panda's food is practically limited to bamboo. The black bear's territory is also much more vast and less isolated. It can move and adapt to a new territory.

**Answers expected in the student booklet – page 16 - AST**



**ACTIVITY 3: The jaws and levers**



	Nutcracker	Panda
What element act as the "force"?	<u>The hand</u>	<u>The chewing muscles</u>
What element act as the "resistance"?	<u>The nut (in this case, it is the tennis ball on the table)</u>	<u>The food</u>
Where is the fulcrum located?	<u>Extremity of the nutcracker</u>	<u>Above the level of the teeth</u>
Compare the levers in the two drawings.	<u>Class 2 lever</u>	<u>Class 3 lever</u>

Which of these two leverage systems has the greatest mechanical advantage to ensure grinding? Explain.

The nutcracker, since the distance between the fulcrum and the force is greater than the distance between the fulcrum and the resistance, which results in a lever with a positive mechanical advantage.

**Answers expected in the student booklet – page 18 - AST**



**ACTIVITY 4: The jaw and diet - AST**

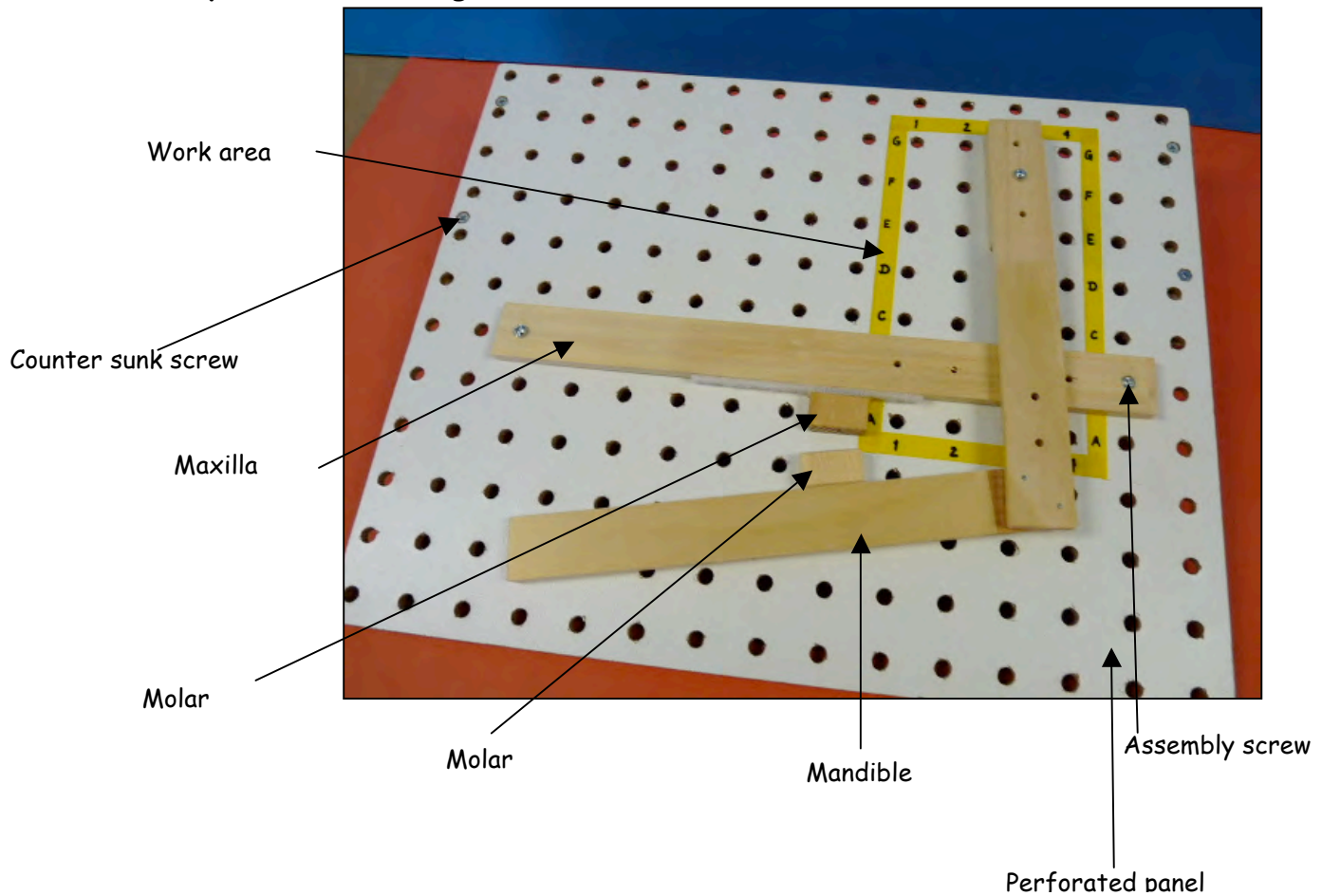
NOTE: We don't indicate an ideal position since the number of holes may vary depending on the panel that is used.

The students should note that in the case of the panda, the marshmallow is squashed and stretched, while in the case of the bear, it is only squashed. Also, the upper and lower molars should be aligned at rest and during mastication. In addition, the maxilla and mandible should be aligned.

The giant panda	Observations and explanations:																																																																																																																																																																
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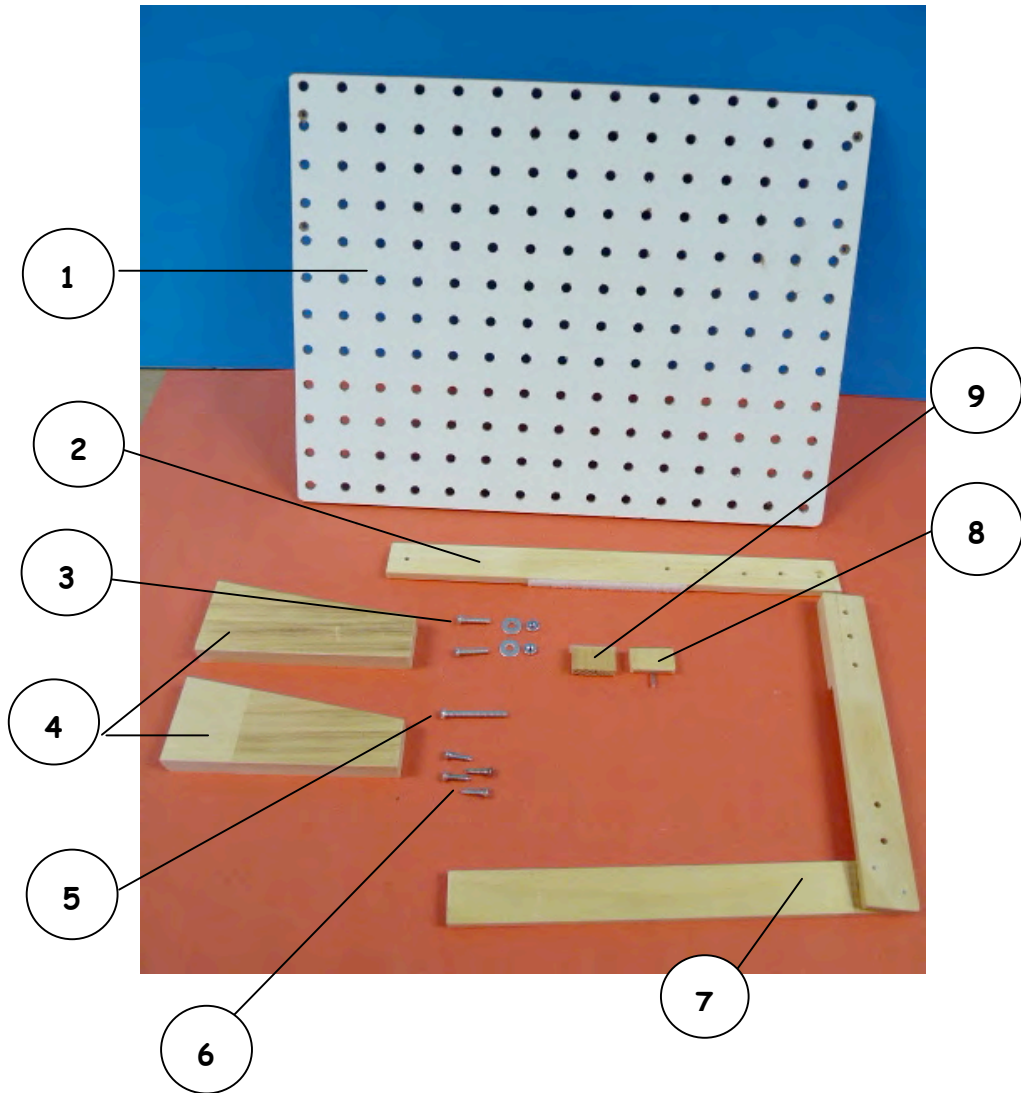
## Activity 4 - Preparing the assemblies for the study of the jaw

### Assembly for the chewing simulation



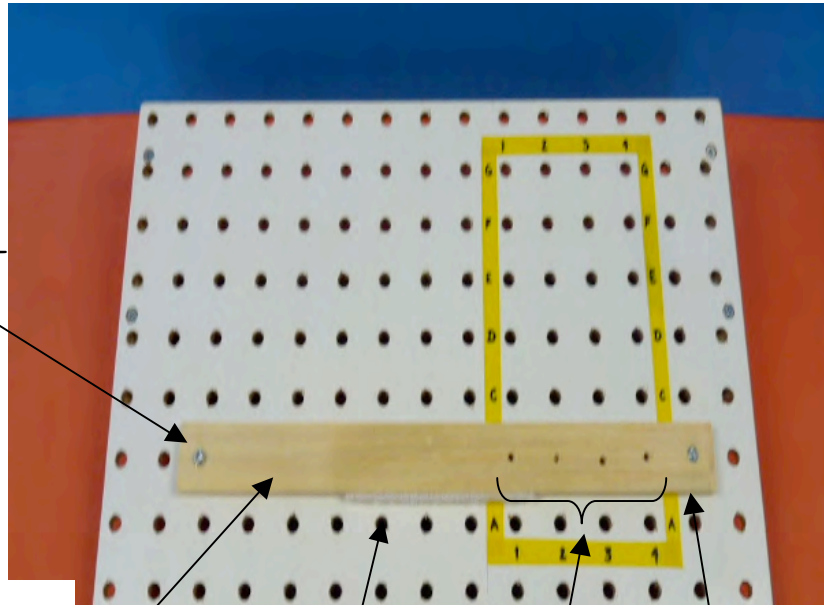
- 1) Perforated panels are already used in most schools to carry out assemblies in science and technology. If this is the case where you are, you will not have to make any, they will not be damaged by the assembly.
- 2) A work area is defined on the panel to help the student when he sketches the assembly in his workbook. He can thus note the exact location of the pivot for each of the jaws (e.g. the pivot is in hole F3). The work area is defined using an adhesive tape on which letters and numbers are written. Its approximate dimensions are 180 mm X 100 mm. You will find a template to cut out and glue in Annex 4. It is preferable to use repositionable glue, either in tape form or in aerosol.
- 3) The food being chewed is simulated by a miniature marshmallow which does not appear in the picture. Foresee 2 or 3 per assembly.

**Description of the parts:**



Reference	Description
1	Perforated <i>Masonite</i> panel approximately 300mm X 400 mm.
2	Maxilla: pine slat 27 mm x 8 mm (see detail on the following page)
3	2 round head bolts, washers and nuts (no. 6-32 1/2 in)
4	2 pine studs 12 mm thick (see detail on the following page)
5	Assembly screws (no. 6-32 1 1/2 in)
6	4 counter sink screws (no. 6 - 1/2 in)
7	Mandible: pine slat 27 mm x 8 mm (see detail on the following page)
8	Lower molar: pine slat 27 mm x 8 mm x 10 mm and 1 in. finishing nail
9	Upper molar: pine slat 27 mm x 8 mm x 10 mm and self adhesive strip of <i>Velcro</i>

**Detail of the maxilla affixed to the panel:**



Round head bolts, washers and nuts (no. 6-32 1/2 in)

27 mm x 8 mm x 305 mm pine slat drilled at each end to allow it to be affixed to the panel.

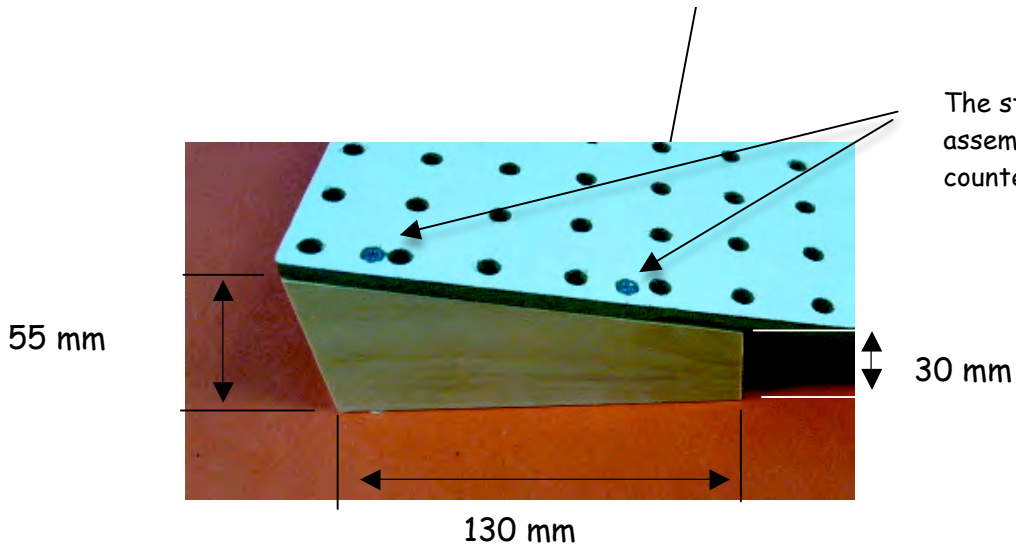
NOTE: The position of the drill holes depends on the position of the holes on the panel.

Self adhesive strip of *Velcro* 8 mm x 15 mm affixed to the maxilla. It allows the upper molar to be moved.

Holes for working in the defined area. their position is in relation to the position of the holes in the panel.

Round head bolts, washers and nuts (no. 6-32 1/2 in)

NOTE: It is necessary to countersink this hole in order not to impede the movement of the mandible.

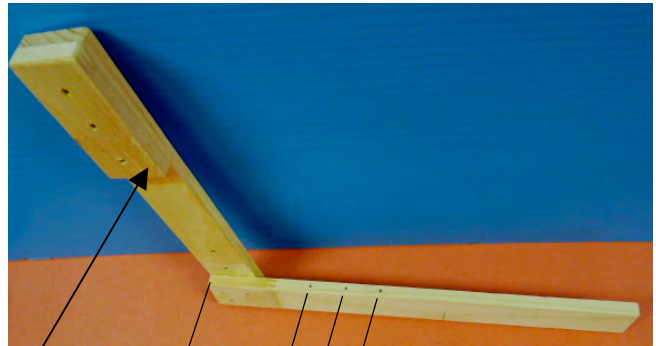
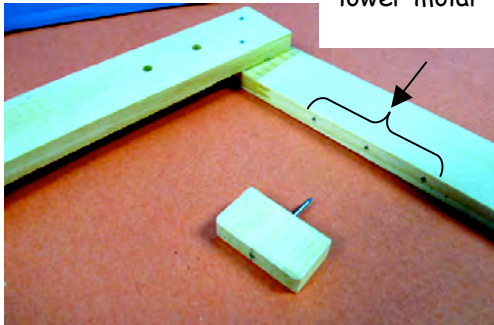


The studs are assembled using counter sunk screws.

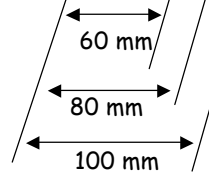


**Detail of the mandible (mobile part):**

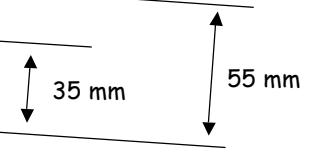
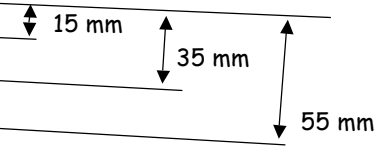
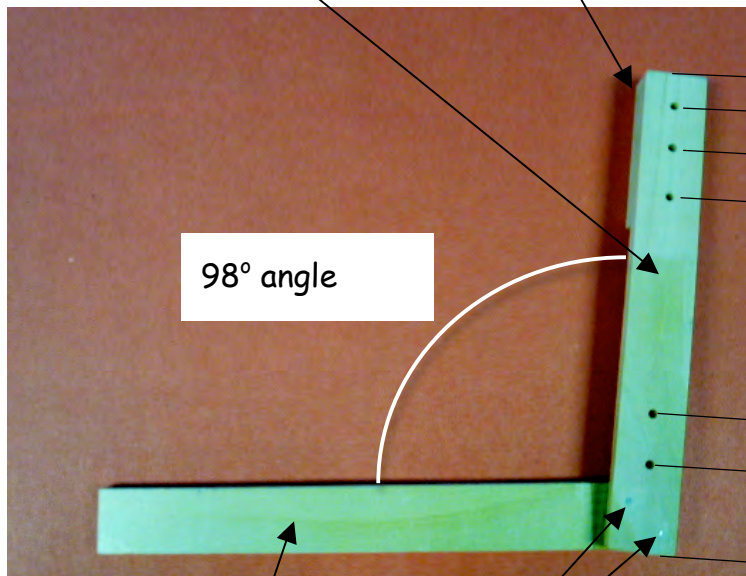
3 holes to allow the lower molar to be moved



Glued 27 mm x 8 mm x 67 mm pine slat.  
NOTE: drilling is done once the two slats are assembled.



27 mm x 8 mm x 203 mm pine slat



27 mm x 8 mm x 240 mm pine slat  
NOTE: The two slats are assembled at a 98° angle. The assembly is made with wood glue and 2 finishing nails cut to a 15 mm length, or with a staple.

## ANNEX 1

### The pictograms



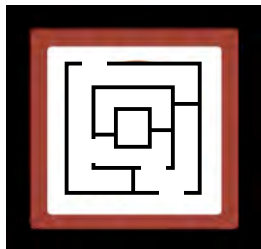
**Presentation of the challenge and the context**



**Activity that may involve things you know**



**Activity allowing you to acquire new knowledge**



**Activity where you will have to plan your work process**



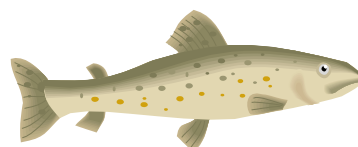
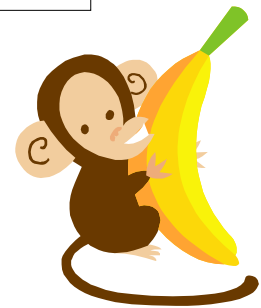
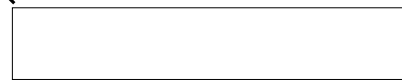
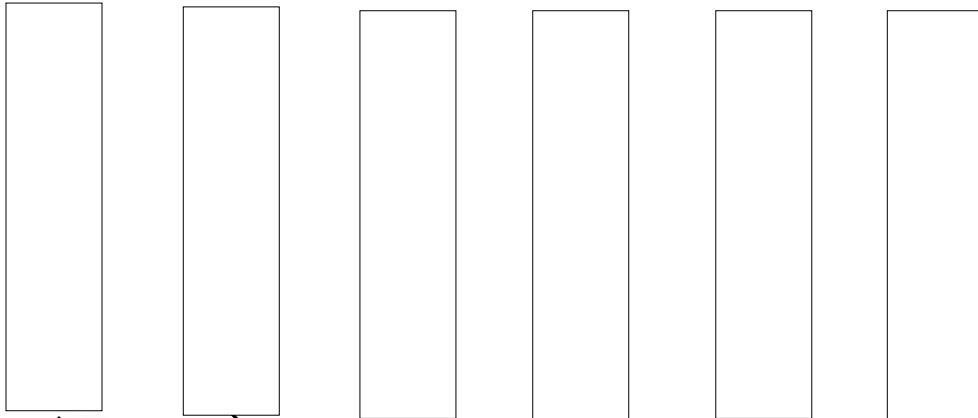
**Independent work activity that involves all your knowledge**



**Activity where you will have to use what you learned in the learning situation**



# Cladogram to complete



**ANNEX 3****Words to be used with the cladogram**

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

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

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

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

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

Template for work area to be cut out and glued onto the perforated panel for activity 4.

