Staying Warm: Animal Size

Here we are going to investigate how size matters if you want to keep warm.

A big animal is not simply a small animal made bigger. As you increase in size, the amount of surface you have for each unit of volume of your body goes down. This is what we call the surface area to volume ratio, and it is a key idea in biology. We are going to look at why this happens using a very simple shape - a cube – and a bit of maths.
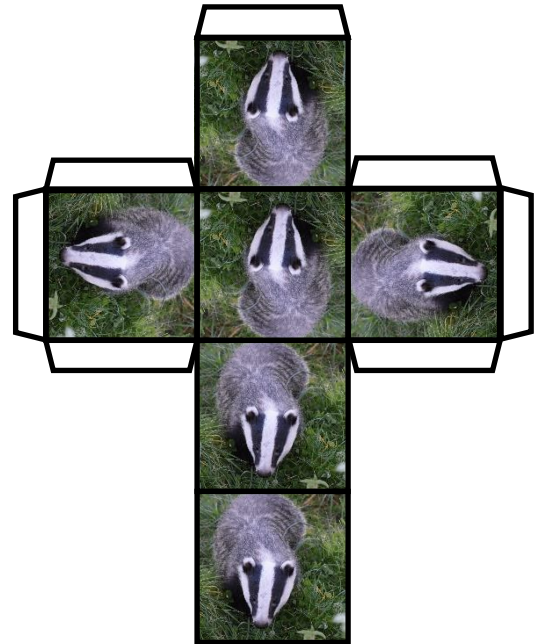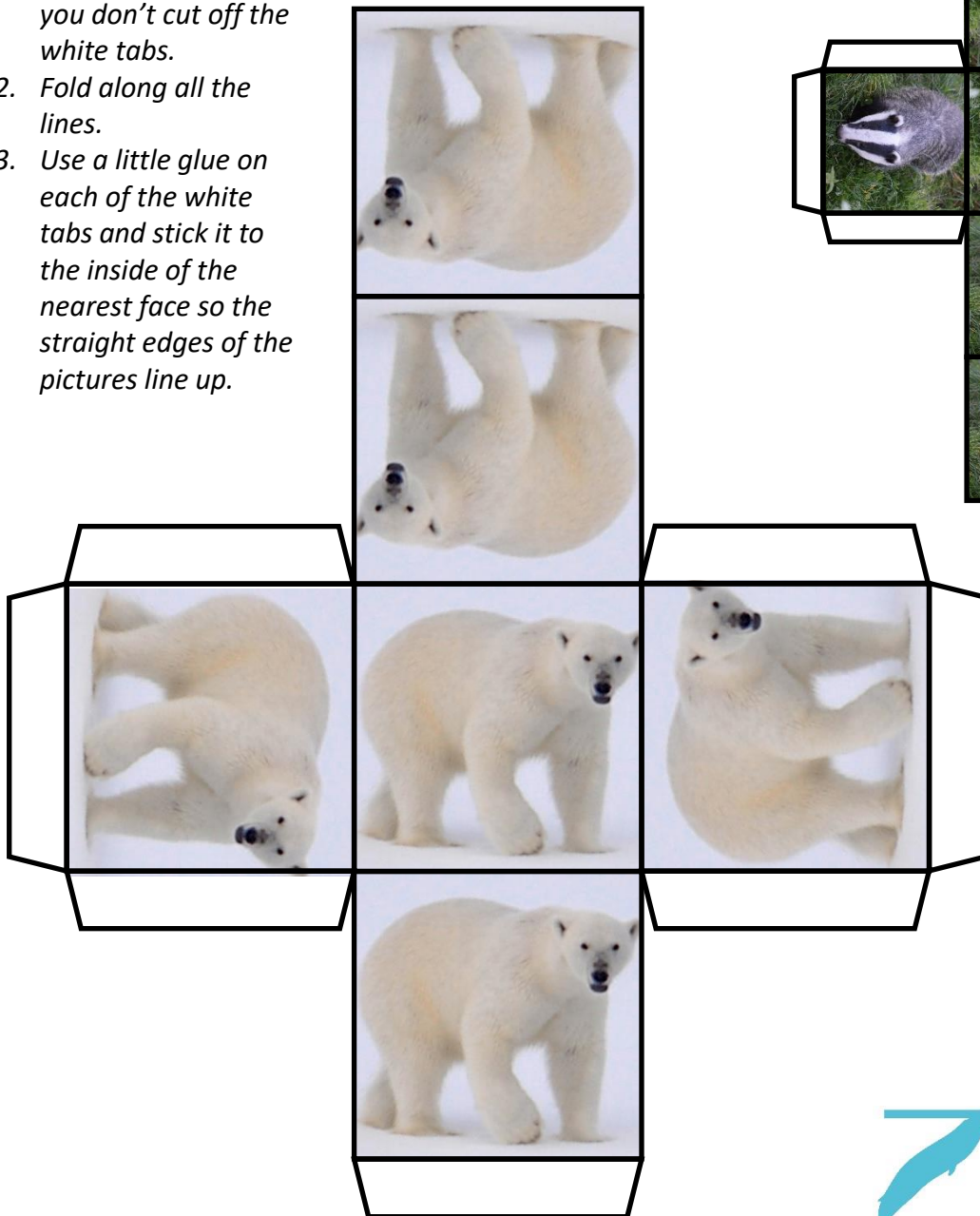
First, cut out and make up these animal cubes. There are two sizes here:

Polar Bear: 4cm x 4cm x 4cm   Badger: 2cm x 2cm x 2cm

To make a cube:
1. *Cut out around the outside, making sure you don't cut off the white tabs.*
2. *Fold along all the lines.*
3. *Use a little glue on each of the white tabs and stick it to the inside of the nearest face so the straight edges of the pictures line up.*

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Now with your animal cubes for inspiration, it's time for a bit of maths.
Take a look at the Badger cube.

- Each side of this cube is 2cm, so it is 2cm high by 2cm wide by 2cm deep.
- Therefore each face is a square with an area of 4cm² (2cm x 2cm).
- There are six faces, so the total surface area of the badger cube is $4cm^2$ x 6 = $24cm^2$.
- To work out the volume of a cube, multiply height by width by depth: 2cm x 2cm x 2cm = $8cm^3$.

Can you do this bit of maths for the Polar Bear cube, with its sides measuring 4cm?

Animal cube	Length of Side	Area of one face *(side length x side length)*	Total surface area *(face area x 6)*	Volume *(side length x side length x side length)*	Surface area ÷ volume
Badger	2cm	2cm x 2cm = $4cm^2$	$4cm^2$ x 6 = $24cm^2$	2cm x 2cm x 2cm = $8cm^3$	24 ÷ 8 = 3
Polar Bear	4cm				

The last column of the table is the one we are interested in. This is that surface area to volume ratio. For the badger it means that for every $1cm^3$ of volume it has $3cm^2$ of surface in contact with its environment. You should have found a much smaller amount of surface per $1cm^3$ in the Polar Bear.

Why is this important when it comes to keeping warm?

You can think of the volume here as the cells that are making the body heat in a warm-blooded animal like a Badger or Polar Bear, and the surface area as the skin that this body heat will be lost over. The more skin there is for each $1cm^3$ of heat-producing cells, the faster heat will be lost to the environment.

Using this idea of surface area to volume ratio, how do you think animals might be adapted to living in cold places? Answer: by reducing their surface area as much as possible. This can be through being large, like our Polar Bear. No all animals are this big, and they might reduce their surface area in other ways, such as having small ears.

Look at the difference in the size of the ears of these two foxes. The Arctic Fox on the left lives in colder habitats and has much smaller ears than the Red Fox on the right, helping it to keep the amount of surface area it has to lose heat across to a minimum.