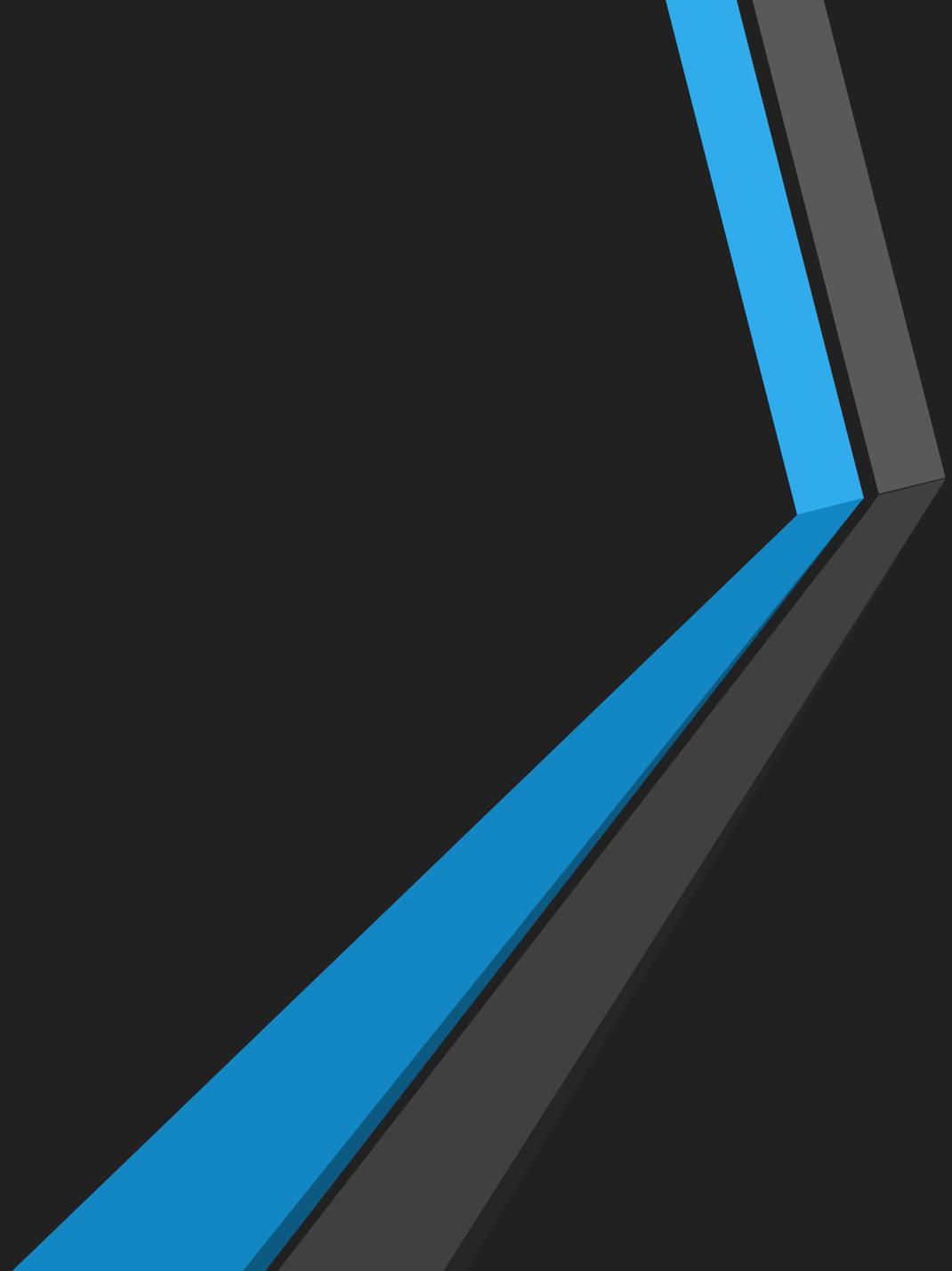


Elastic bones

Team Romania



The problem

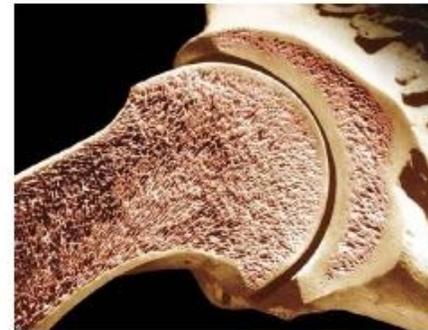
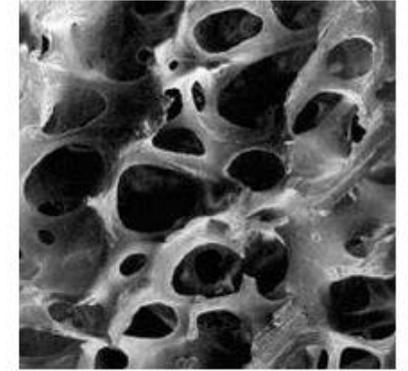
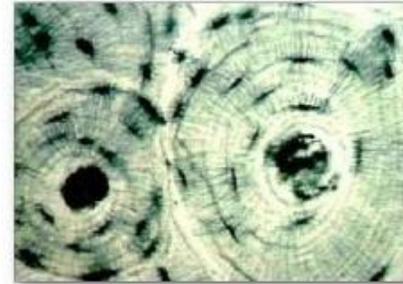
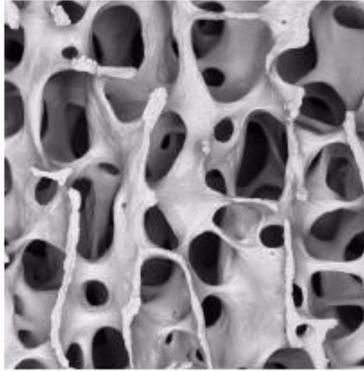
- Chicken bones kept in acidic conditions for a few days become elastic. Perform such an experiment in controlled conditions and investigate what components of bones are responsible for their mechanical properties.

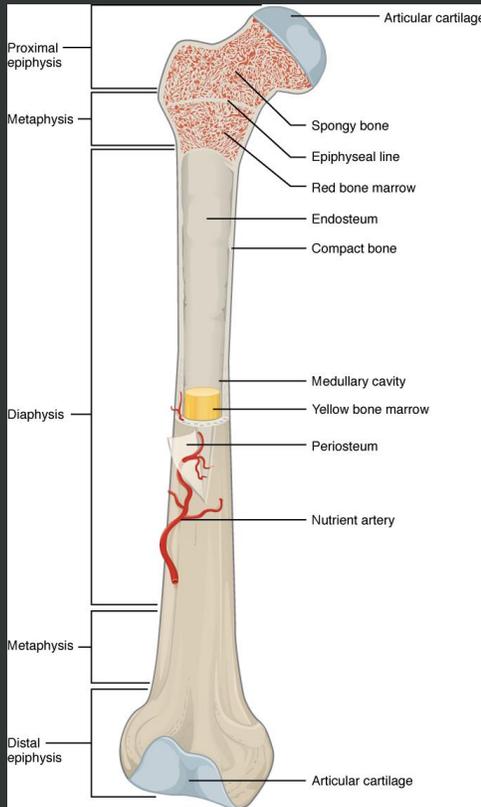


The structure of the bone

Microscopic:

-Bone tissue is a hard tissue. It has a honeycomb-like matrix. This mineralized matrix has an organic component made up of mostly collagen and an anorganic component made up of various salts. They make up almost 70% of the total bone mass.



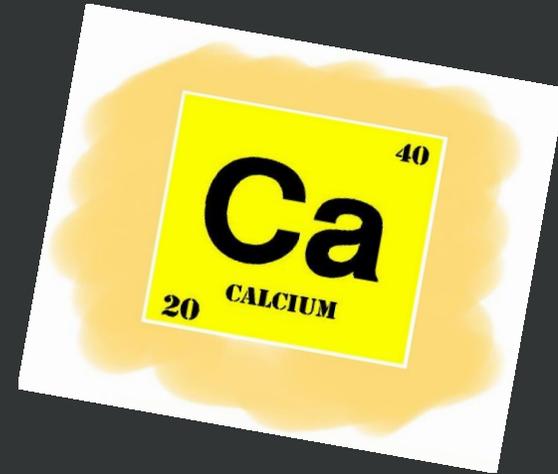


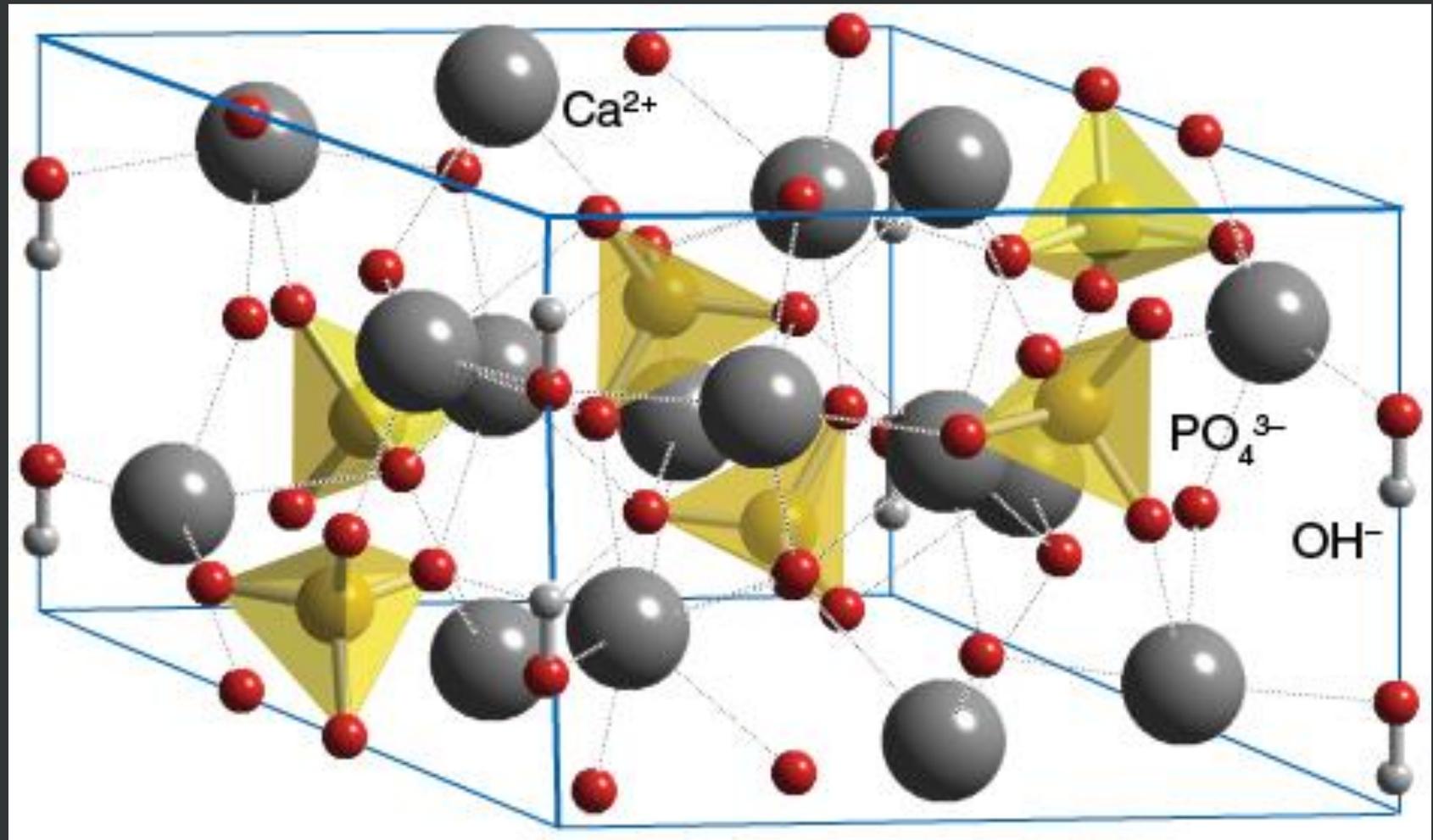
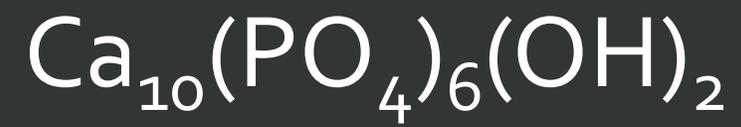
Macroscopic:

- A relatively large bone has two main parts: the epiphysis and the diaphysis;
- The epiphysis is filled with spongy bone, the cells having a larger space between them;
- The diaphysis is the tubular part that runs in between the two heads of the bone. It is made up of dense and compact bone.

What is hydroxyapatite?

- Up to 50% by volume and 70% by weight of human bone is a modified form of hydroxyapatite, known as bone mineral.
- Hydroxyapatite forms and hardens inside the bone matrix after calcium, magnesium and phosphate ions are deposited by the osteoblasts when bone tissue is created.





How hydroxyapatite reacts to acids

$\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ is a sparingly soluble salt. It continuously partakes in a two sided reaction in which it breaks down and is reformed:



When acid is added, the balance of the reaction is accordingly moved to the right, since it reacts with the ions which act as bases,



This removes them from the equilibrium, causing the equilibrium to shift to the right (Le Châtelier's Principle).

The Experiment

- USING ACETIC ACID(vinegar)

Before the experiment



For the experiment we used the following supplies:

- a clean glass jar;
- wine vinegar (acetic acid);
- a chicken thigh bone (with as little soft tissue as possible);

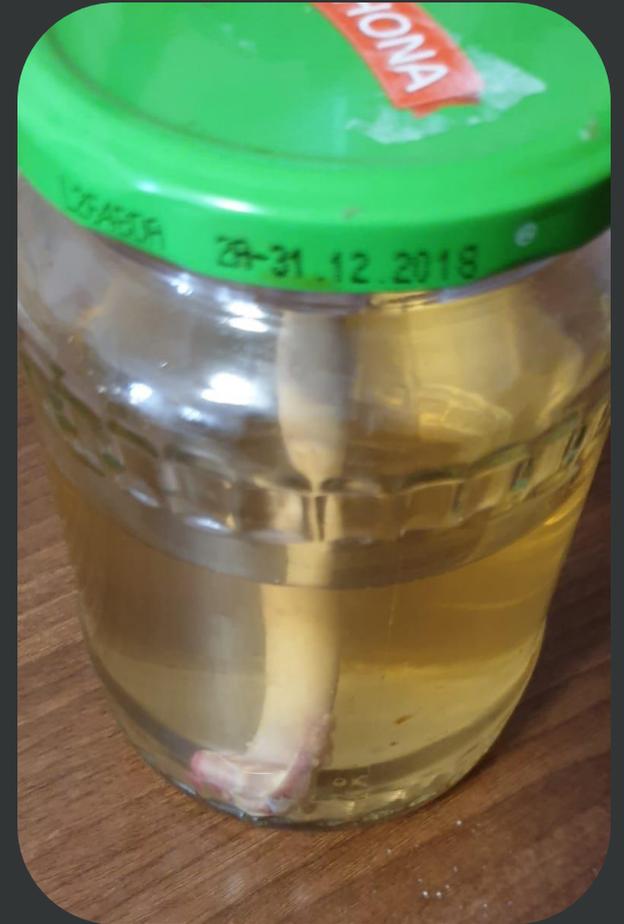
Note: The vinegar used had a relatively pale colour, so that any change in the solution could be visible.



Step 1: Using a knife, scrape off of the bone any remaining soft tissue.

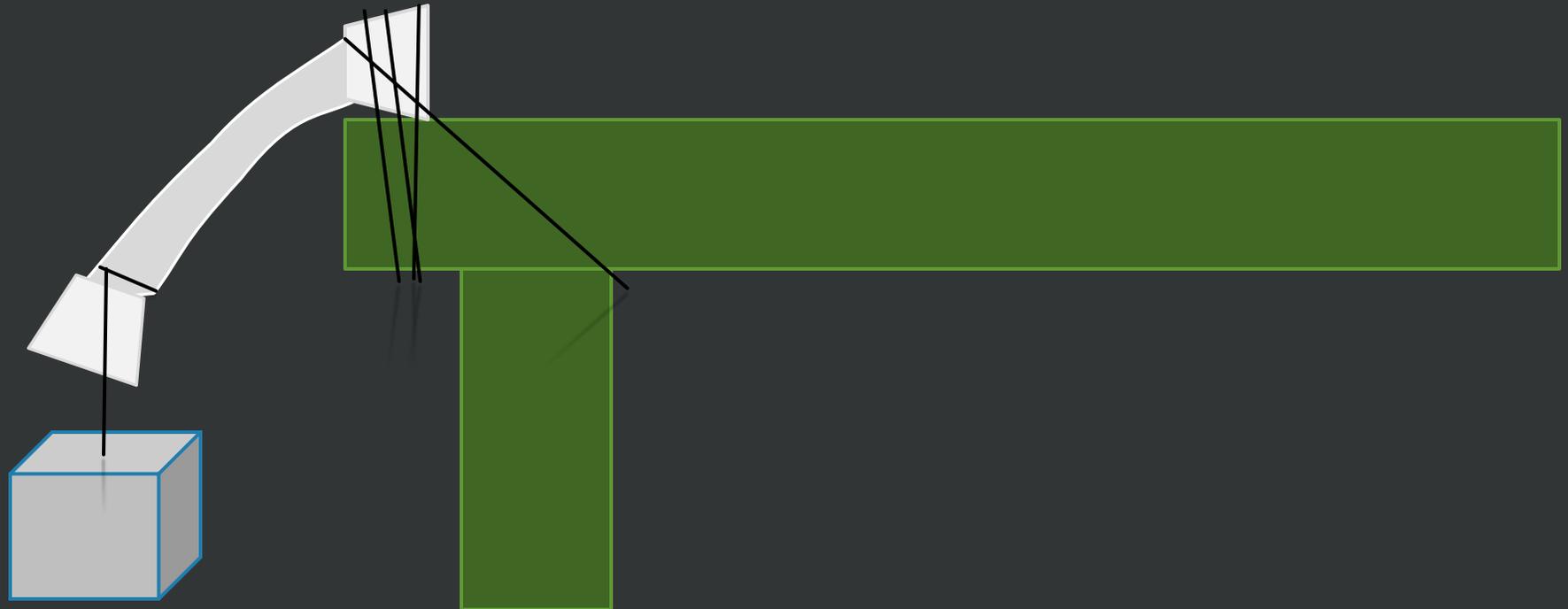
Step 2:Submerge the bone completely under the solution.

Step 3:Wait for a few days . This, indeed is the hardest step, but you can see early results after just 4 days if you use a store bought chicken thigh.



How elasticity was measured

- The bone was fixed to the table and the weight was tied to the other end.
- After that, the angle between the bone's diaphysis and the table is measured.



Day 1, 2, 3

- Not many changes to the natural bone's elasticity, but the storebought one already can bend at 45 degrees.
- Both solutions are now darker and became a little opaque.



Days 4, 5, 6

- The storebought bone already peaked in elasticity, while the natural one is still in the process of becoming elastic.
- The tendons and ligaments became transparent, whilst the epiphysis are getting really dark, almost black in color
- The solutions are now both opaque and a dark residue is at the bottom of the jars



Day 7+

- The natural bone is starting to plateau in elasticity, but it doesn't even compare to the storebought one.
- Both bones are visibly darker, especially the ends.
- I end the experiment at day nine.



End of experiment



- As assumed, the bone has now lost its rigidity and can be bent in all sorts of manners.
- It also has really high elasticity, as such, when the bone is bent it will almost immediately recover its original shape;
- Although now flexible, it still takes a decent amount of force to bend. This may be because the acid might have not soaked all the way through the tissue.

Additional observations



- The bone is now a visibly darker hue.
- The bone hasn't got the same elasticity throughout its length. This is because of the macrostructure of bone tissue, the spongy bone being, in the end, more flexible than the dense one.
- At the transition between the epiphysis and diaphysis you can feel a hollow space in



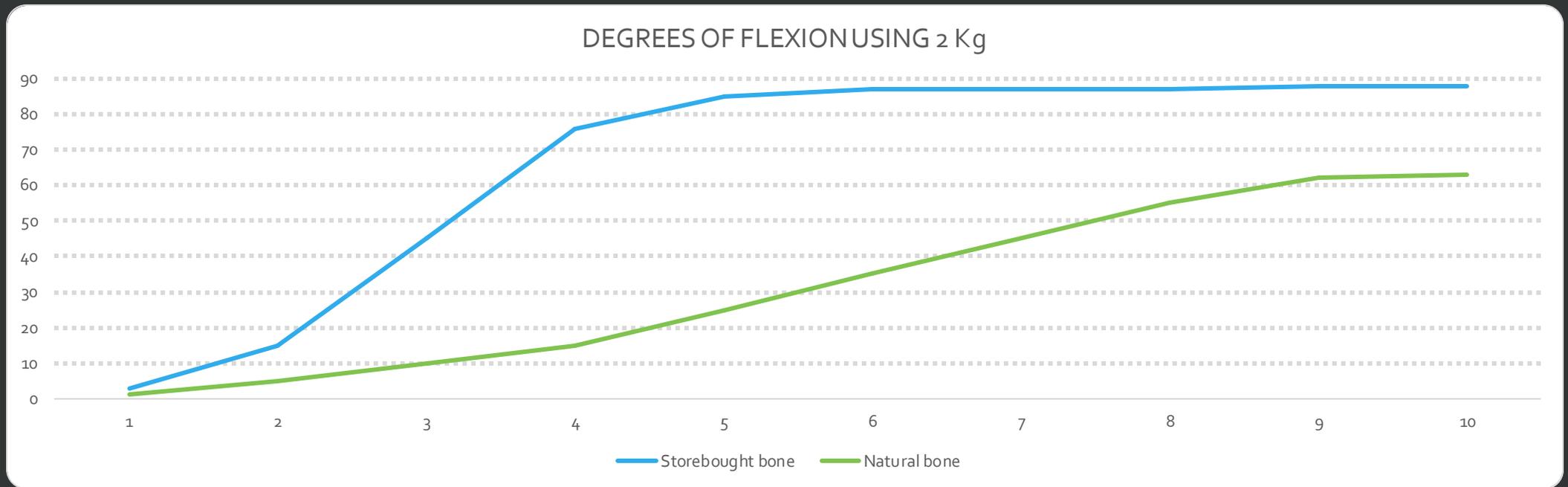
the bone. This is the bone marrow channel that can now be felt through squishing the bone.

-The solution has also darkened in colour. Parts of the soft tissue still attached to the bone have fallen off and settled at the bottom of the jar.

-Besides a change in hue, the vinegar is now less transparent. Now you are barely able to see all the way through the jar.



Results of measurements



Interpretation of data

- We can see that the natural chicken bone is both denser as a whole and richer in hydroxyapatite. This results in a way longer process of demineralisation and less visible results.
- This difference can be explained by difference in diet, species, age and mobility during the lifetime of the chicken, factors that play a role in bone density and mineralisation



Possible errors

- Results might vary when using different acids;
- The chicken thigh from which we extracted the bone was storebought. The processes which it was subjected to might affect the experiment;
- The jar was sealed during the experiment. Because of this, any gases that would have normally left the solution have remained in the container and may have even affected some reactions that took place;
- The bone was not perfectly clean of soft tissue. This tissue may have partially dissolved and caused some of the changes that were observed in the solution.

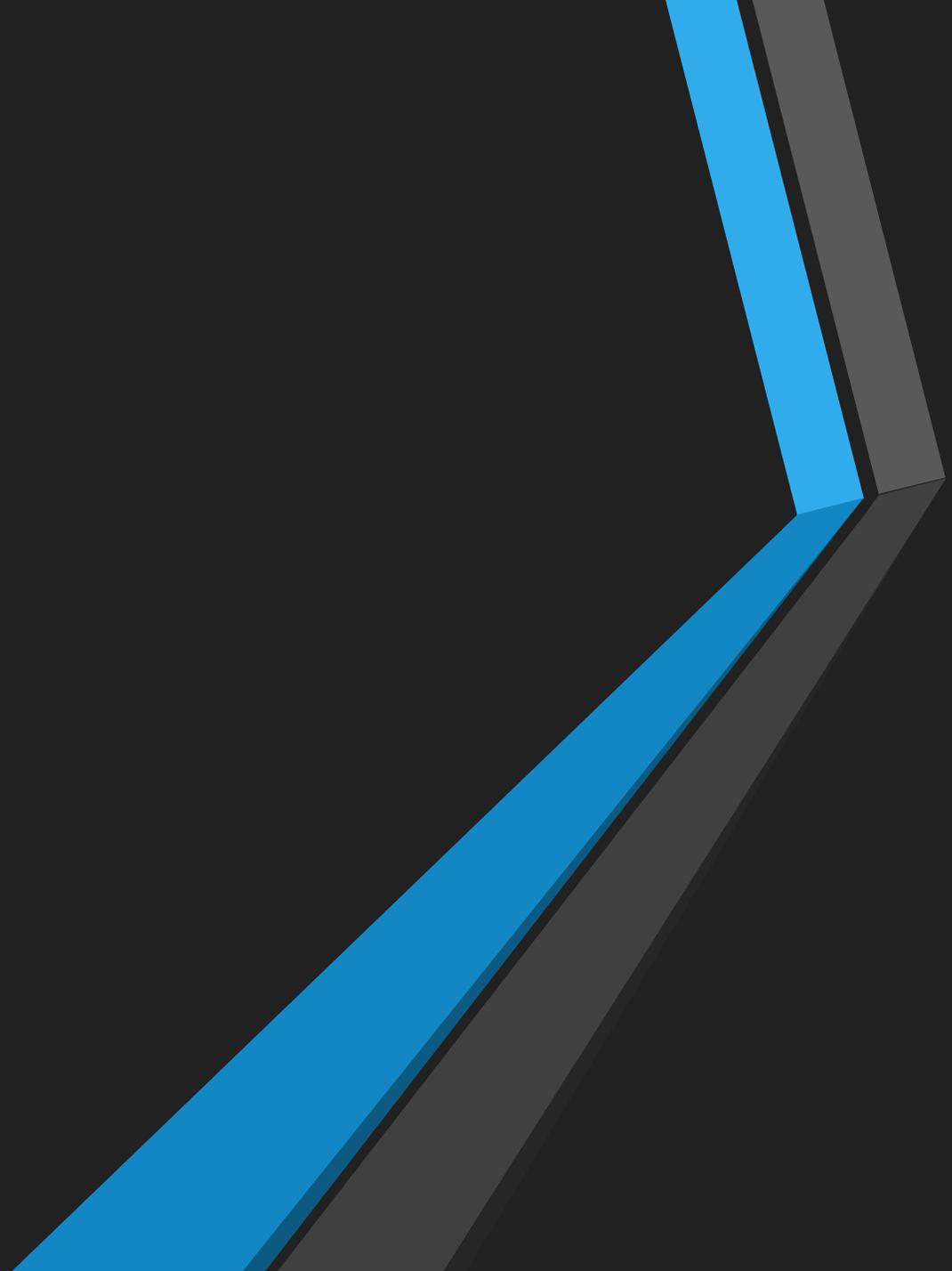
Conclusions

- When kept in an acidic environment, after a few days, bones will become elastic and flexible. This confirms our original hypothesis.
- In addition to the obvious change that occurred in the properties of the bone, we also observed other changes, such as the difference of elasticity throughout the bone.
- The bone itself was not the only one that changed. The vinegar also became opaque and darkened in hue, along with the PH of the solution rising.

Bibliography

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Thank you!

A decorative graphic in the bottom right corner of the slide. It consists of several overlapping, parallel lines that create a sense of depth and movement. The lines are primarily a vibrant blue and a dark grey, set against a black background. The lines appear to be part of a larger, abstract geometric shape that is partially cut off by the edge of the frame.