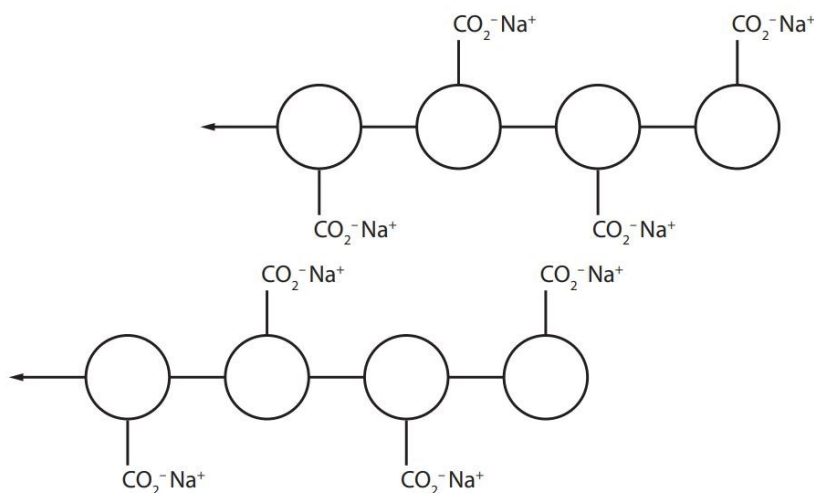


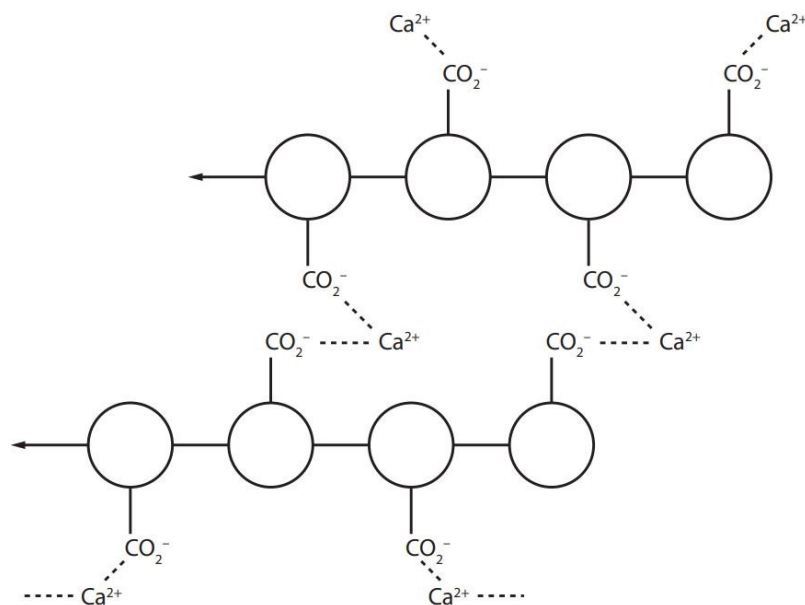
## Cross-linking polymers – alginate worms

### Introduction

Sodium alginate is a polymer which can be extracted from brown seaweed and kelps. It is one of the structural polymers that help to build the cell walls of these plants. It has some unusual properties and a wide variety of uses. The polymer can be represented like this:



When sodium alginate is put into a solution of calcium ions, the calcium ions replace the sodium ions in the polymer. Each calcium ion can attach to two of the polymer strands. This is called cross-linking and can be represented like this:



Collect approximately 5 cm<sup>3</sup> sodium alginate suspension or Gaviscon® solution.

### Equipment

#### Apparatus

- Eye protection
- Dropping pipette
- Beakers, 150 cm<sup>3</sup> x 2

- Labels for the beakers

### Chemicals

- Sodium alginate suspension or Gaviscon®, approx 5 cm<sup>3</sup>
- Sodium chloride solution, approx 100 cm<sup>3</sup>
- Calcium chloride solution, approx 100 cm<sup>3</sup>

### Health, safety and technical notes

- Read our standard health and safety guidance here <https://rsc.li/3X7Kx2S>
- Always wear eye protection.
- Chloride solutions are eye irritants over 10% (see CLEAPSS Hazcard [HC047b](#)).

### Procedure

1. Put the calcium chloride solution into one of the beakers and the sodium chloride solution into the other. Label the beakers clearly.
2. Using the pipette, squirt the sodium alginate or Gaviscon® into the calcium chloride solution.
3. You are aiming to make 'worms,' although you can make beads if you prefer.
4. Remove a few of your worms straight away and put them into the beaker of sodium chloride solution
5. Swirl both beakers gently and observe what happens to the worms in each one.
6. You can remove and squeeze the worms as well as observing their appearance.
7. You will need to wait a few minutes for all the reactions to be complete.

### Notes

- Alginate is used in many applications, and new ones are being found all the time. The uses range from applications in the food industry to wound dressings, medicines and dental impression materials.
- Calcium alginate (the cross-linked polymer) is used in wound dressings. These dressings are particularly useful for slow healing wounds like leg ulcers, which can continue to bleed and weep for a long time. Part of the blood clotting mechanism involves calcium ions and on contact with blood the calcium alginate releases calcium ions in exchange for sodium ions – just as you observed in the experiment above.
- These extra calcium ions can help the blood to clot and encourage healing. It is easy to remove any excess calcium alginate when the dressing has to be changed.

### Questions

1. Describe the sodium alginate suspension or Gaviscon®.
2. What is the formula of
  - a. A sodium ion?
  - b. A calcium ion?
3. Why can the calcium ion attach to two strands of the polymer, but the sodium ion to only one?
4. Predict how you think the properties of the polymer will change when it is poured into a solution of calcium ions.