

The Calcification Challenge

Experience Ocean Acidification from a Coral Reef's Point of View

Objective:

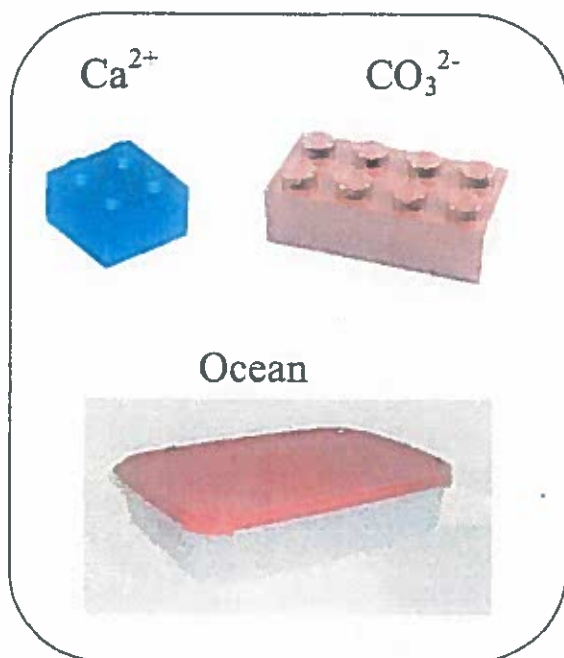
The purpose of this activity is to convey how ocean acidification (OA) affects marine calcifiers' ability to build their CaCO_3 structures (e.g., shells, skeletons, etc.). OA reduces the availability of carbonate ion "building blocks" and therefore reduces the rate of CaCO_3 production.

Materials:

- Legos (2 colors/ sizes)
- 2 Tupperware bins (shallow rectangular ones work well)
- Water (*optional*)
- 2 Lego base plates (*optional*)
- Audio player (e.g., computer, smartphone)
- Art Supplies for labels and signs (e.g., markers, poster board, construction paper)
- Paper Towels (*if using water*)

Things to consider when choosing Legos:

- Ca^{2+} is smaller than CO_3^{2-} so we use a smaller Lego to represent Ca^{2+} .
- The different colors also distinguish the two ions, which makes set up and counting up the total amount of CaCO_3 produced easier. If the colors were the same, these steps would be more difficult but it might eliminate the need for participants to close their eyes.
- The Lego shapes for Ca^{2+} and CO_3^{2-} are optional. However, if they are somewhat similar (e.g., the same size in one dimension/ not too different in the others), it takes longer for participants to determine, by touch that they have one of each of the CaCO_3 building blocks. The longer "ion identification" takes, the greater the discrepancy between how long it takes to make a CaCO_3 unit in the future vs. the present day ocean.



Set up:

- 1) In two large Tupperware bins, place an equal number (~500) of the smaller Legos:

One bin represents the ocean today while the other represents the ocean in a high- CO_2 future. Each bin contains the same number of smaller Legos, which represent calcium ions, because rising levels of CO_2 do not directly affect ocean Ca^{2+} concentration.

- 2) Put $\frac{1}{3}$ to $\frac{1}{4}$ of the (~100 total) larger, CO_3^{2-} Legos into the "Future Ocean" and the remainder into the "Today Ocean"

Note: these ion concentrations are exaggerated for the purpose of illustrating the impact on calcifying organisms.

- 3) *Optional* Fill the bins with water (~1-2 in. below the rim of the bin)
- 4) Label each ocean

Example: "Today" and "Future" or "High CO_2 "

Participant Instructions:

- 1) Briefly explain how corals need Ca^{2+} and CO_3^{2-} in order to construct their CaCO_3 skeletons but that elevated levels of CO_2 in the atmosphere and ocean results in a reduced amount of CO_3^{2-} building blocks.

Note: More information regarding ocean carbonate chemistry may or may not be appropriate depending on the age/ interest level of the group.

Note: This, or parts of this information could also be presented after the relay, with the participants initially only knowing that each bin represents the ocean and its Ca^{2+} , CO_3^{2-} concentrations either today or in the future.

- 2) Divide the group into two teams, one for each ocean
- 3) Each team will send one member up to their ocean at a time. With their eyes closed, this team member will locate and put together one Ca^{2+} and one CO_3^{2-} Lego. At this point they can open their eyes, return to their team and add their unit of CaCO_3 to their reef (if using them, the Lego base plate acts as the sea floor).
- 4) Once a team member returns, the next team member goes up to their ocean and repeats the process.
- 5) Similar to musical chairs, the relay begins and ends with musical accompaniment

Song Suggestions: 'Under the Sea', 'Beyond the Sea'

- 6) When the song/relay ends, have the teams count and report the number of CaCO_3 units in their reef (usually just count the number of one color Lego).
- 7) Which team has the most CaCO_3 ? Why? If desired, repeat the game a few times and switch up the teams.

Potential Discussion Points:

- **Comparing/ contrasting with the real world:** In reality, it takes many years, decades and even centuries for corals to reach their full size and build extensive reef systems. We have also exaggerated the difference between present and future carbonate ion concentrations; the difference is actually smaller but because corals are constantly building their skeletons periods over many years, the impact of OA eventually shows up in the calcification rate.
- **Reefs are made of many different types of corals; corals are colonies made of many individuals:** Each team member contributed to building the CaCO_3 reef, which is exactly what happens on a real coral reef; not only are there many different types of corals on a reef (e.g., brain corals, branching corals) and calcifying organisms (e.g., corals, calcareous algae), but each coral is made up of many individual-yet-connected, little anemone-like polyps that contribute to building the coral's CaCO_3 structure.
- **Variability among coral organisms and reef systems:** Not all corals respond the same way to OA. While some are highly sensitive others seem unaffected. Each team member may have a different approach to locating and putting together their pieces of CaCO_3 : one person may have had a faster way to locate carbonate ion blocks. Therefore, the amount of reef each team was able to build was due, not only to the availability of each ion building block but also to how each team member approached the task of "calcification". (Possible demonstration: play the game again, but this time, allow the High CO_2 team keep their eyes open so they can take advantage of the color contrast to speed up their "calcification rate")