The Calcification Challenge

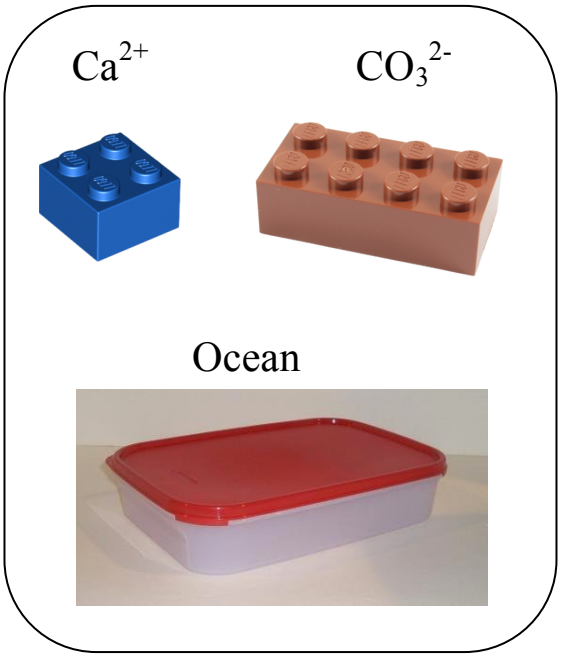
Experience Ocean Acidification from a Coral Reef's Point of View

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)
- 2 Lego base plates (*optional*)
- Audio player (e.g., computer, smartphone)/ or stop watch
- Art Supplies for labels and signs (e.g., markers, poster board, construction paper)



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 the total amount of $CaCO_3$ produced easier. If the colors were the same, these steps would be challenging but could 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 length on one side), the difference between the future and present day reefs will be more pronounce because it takes longer for students to determine that they have one of each of the $CaCO_3$ building blocks.

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 ⅓ to ¼ 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 activity, with 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'

ALTERNATIVELY

The entire team can sit around its respective ocean and all students can put together "$CaCO_3$" at the same time. This generally works better because all students are participating at once rather than one at a time. However, the carbonate ion Legos get used up much more quickly and probably won't last for the duration of a song; best to shorten the time for the activity so participants are not left with the impression that the ocean will run out of CO_3^{2-} completely!

6) When the song/relay/time 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. In reality, the difference is much smaller but because corals are building their skeletons all the time and over longer time frames, the impact eventually shows.
- **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 reef; not only are there many different types of corals on a reef (e.g., brain corals, branching corals) and calcifying organisms (e.g., 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 $CaCO_3$. The amount of reef each team was able to build was due not only to the availability of each ion building block but also how each team member approached the task of "calcification".

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