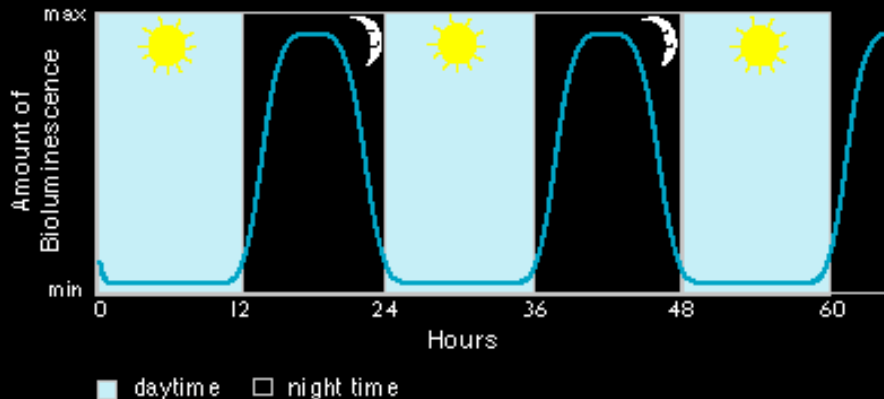


Light Cycles

These dinoflagellates have a [circadian rhythm](#) which controls their bioluminescence and photosynthesis on a 24-hour basis, i.e. they only photosynthesize when they "think" it's day and they only produce bioluminescence or flash when they "think" it's night. So, you need to grow them on a strict light schedule, otherwise their natural rhythms can't synchronize with the light cycle and they won't know when to flash and when not to flash.

Ideally, they should get 12 hours of light and 12 hours of darkness every 24 hours and at the same time every day. If you can do this, the dinos will be brightly luminescent whenever they are in their "night phase" and they will be pretty much non-luminescent when they are in their "day phase". If you have access to a grow light or an aquarium/terrarium light this is ideal, because then you can really control when they get their photosynthetic light. For example, you could grow them in a place that doesn't get any natural sunlight and instead give them artificial light at night so that in the daytime (when the sun is really out) the dinos will think it is nighttime and will be flashing brightly.

If you are doing [experiments](#) with these organisms remember that these rhythms will determine when you should perform the experiments. You should test their bioluminescence at the same time everynight so you know that the organism is at the same point in its natural rhythm each time.



Long term growth

If your dinos arrived in baggies you should transfer them to a sturdier house, like a clear jar or a clear plastic container. In addition to needing light to make food, they need CO₂ (carbon dioxide) which provides them with the carbon they need to make sugars. So, loosen the lid of whatever container you keep them in so that air can get in and out. If the seawater that your dinos came in starts to evaporate you can add bottled water (because only the water evaporates not the salts) in small amounts. Only replace the amount that has evaporated otherwise you will dilute the seawater too much. Also, it's a good idea to add a small drop of Miracle Grow fertilizer every couple of months to supply the dinos with nitrates and phosphates which they need to grow.

And if you really want to keep your dinos alive for a long time, you can make all new seawater for them by mixing Instant Ocean (a mix of salts purchased from any aquarium store) and tap water. Fill a couple of clear jars full of the new seawater, add a couple drops of Miracle Grow to each, and then add the dinos. If this routine is performed every few months they should live forever.

Experimenting with the bioluminescence

There are many different simple experiments you can do with your bioluminescent dinos.

In a similar fashion to the way we perceive being touched, this is the type of stimulation that causes a dinoflagellate to produce a flash of light. Dinos are highly sensitive to anything that pushes on their cell wall, even the seawater they live in can cause them to flash if it becomes very rough and stirred up. That is what is happening whenever you shake the container that your dinos live in, the water is becoming very turbulent and pushing on their cell walls causing them to flash.

- What other types of stimulation cause them to flash?
- How much stimulation can the dinos withstand before their bioluminescence is exhausted? How long does it take for them to recover?

Changing their light cycles is an interesting study, but remember that it takes the dinos about a week to get used to the new light cycle (just like humans who travel to places that are in extremely different time zones, it takes a few days to get used to that time zone, because your circadian rhythms are confused).

- What immediate effects do you see if you put dinos in their nightphase into the light?

If you have a microscope to view the cells with, here are some observations you can make:

- What differences do you notice between a cell in the middle of its dayphase and one in the middle of its nightphase?
Hint: the chloroplasts are the golden-brown bodies within the cell. How might you explain this?
- Examine the different stages in the life cycle of these asexually reproducing cells. (The entire life cycle takes 5-7 days)

Currently, scientists are using the bioluminescence a dinoflagellate produces as an assay for detrimental effects caused by pollution in various marine environments. The bioluminescence that a dinoflagellate can produce reflects how healthy it is.

- What types of chemicals might be found in a polluted harbor that might affect organisms that live there?

How to measure the light...

When we test our dinos for light output we put them in small (15 ml) glass vials and stir them with a magnetic stirrer. The method

that CISE recommends for measuring light output is to use a scale from 1-10, with 1 representing a relatively small amount of light and 10 representing a relatively large amount of light. You should always establish a group of cells that serve as "controls" which have been grown in normal conditions. To determine if your experimental cells have been affected by the treatment, compare their light output with the light output of the control cells. It is best to assume that your controls are producing light at level 5, so then if the experimental cells produce more light than the controls you give them a number higher than 5, and if they produce less light than the controls you give them a number lower than 5. Also, you have to be very careful not to "stimulate" the dinos before you actually measure their light output because the first time they flash they produce a lot more light than each successive flash. The other thing you have to consider is that whenever you add substances to the seawater that the dinos are in, that will cause them to flash. Even if you are just adding seawater, the seawater that they live in will be physically disturbed by any liquid being added to it, so the dinos will be stimulated by this physical disturbance of their surrounding water.

There are lots of things you could examine besides these listed here. Try to come up with an entire new idea that you could test using the bioluminescence of dinoflagellates.

Learn More About...

(The last eight links will lead you to different web pages)

- **Dinoflagellates and their bioluminescence**
 - See how bright the bioluminescence in the ocean can be at [Bio Bay](#)
 - Another [picture of *Pyrocystis fusiformis*](#) and a little bit of info.
 - Specifics on dino bioluminescence and more ideas for experiments [Mike Latz \(Scripps\)](#)
 - Information about *Noctiluca*, an unusual and interesting bioluminescent dinoflagellate. [Jan Rines \(U. Rhode Island\)](#)
 - Take a look at a nice [three-dimensional picture of *Noctiluca*](#), taken by Wim van Egmond. Bring your red-and-green glasses!
- **Photosynthesis**
 - [A general definition and more.](#)
 - [Photosynthesis Education page](#), Arizona State Univ.
 - Check out the [virtual chloroplast!](#)
- **Circadian Rhythms**
 - [What is a circadian rhythm?](#)