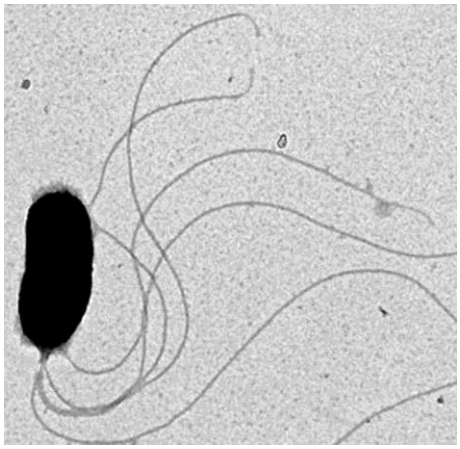
ILLUMINATING SCIENCE - QUORUM SENSING

Dr. van Kessel is holding a flask of glowing bacteria here!



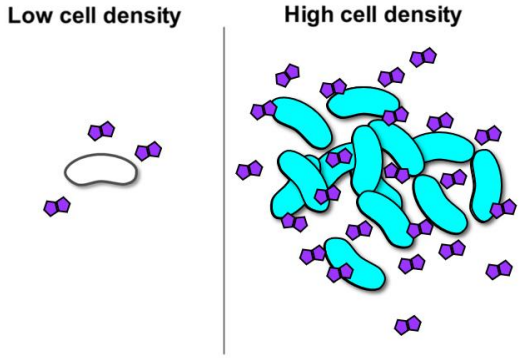
A microscope picture of a Vibrio magnified ~50,000 fold

Background:

Bacteria are super teeny tiny organisms that usually can only be seen with a microscope. They are single-celled organisms that are biologically distinct from plants and animals. Bacteria are responsible for many of the things we see in nature such as producing nutrients in the environment, recycling waste products, as well as causing some diseases.

Many kinds of bacteria "talk" to each other using a cell-to-cell signaling process called ***quorum sensing.*** This allows bacteria to coordinate behaviors that are helpful as a group but aren't as helpful when bacteria are alone in their environment. A great example of this is ***bioluminescence***, which is when living organisms produce light. It is much more beneficial for a large group of bacteria (trillions of cells) to produce light than for only a few cells. There are other behaviors that are also controlled by quorum sensing, including behaviors used by bacteria that cause diseases. These behaviors include metabolism, motility, and the production of biofilms and toxins. We work with bacteria called ***Vibrios*** that live in the ocean and infect fish and shellfish. These bacteria use quorum sensing to control genes that allow them to infect their hosts.

During quorum sensing, bacteria produce, secrete, and detect small molecules called **autoinducers**. These molecules are their method of communication, and the amount of molecules reflects the number of cells in the nearby environment. When the number of cells is low, the level of autoinducers is also low, and the receptors for autoinducers will not be able to detect them. When the number of cells increases as the bacteria grow, autoinducer levels also increase. At higher cell numbers, the receptors detect autoinducers and turn on quorum sensing genes. High levels of autoinducers can be detected by the *Vibrio* receptors and this causes the bacteria to produce bioluminescence, a cool behavior that scientists can easily observe.



With fewer cells around, there is less autoinducers. But if many cells are nearby, cells sense autoinducers and bioluminesce!

Quorum sensing behaviors:

Sort the following behaviors that a group of bacteria show based on whether you think they would be more advantageous as an individual cell ***(low cell density***) versus as a group (***high cell density***).

Biofilm formation Bioluminescence Toxin production Swimming Attachment

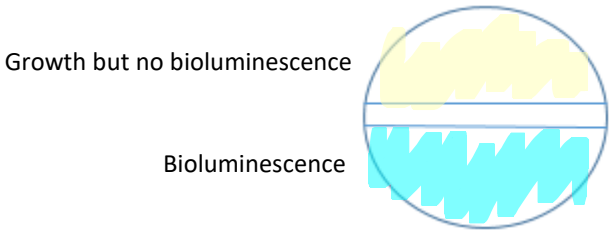
Low cell density behavior	High cell density behavior
Swimming Attachment	Biofilm formation Bioluminescence Toxin production

Note: these behaviors can vary in different bacteria, so some alternative answers are acceptable!

Experiment:

For the following scenarios, imagine you have different ***strains*** (or variants of a bacterium). If one strain can produce its own autoinducers, this strain is a "talker", meaning it can produce those autoinducers around it. If a strain can sense autoinducers with a receptor, this strain is a "listener", meaning it can sense those autoinducers around it and respond. If a strain can both produce and sense autoinducers, it can both "talk" and "listen" to its own autoinducers.

A. What results should we expect to see if we streaked out a strain of bacteria that can only produce autoinducers on the top half of the plate shown below and we streaked a control strain that both produces and senses autoinducers on the bottom half? Which sides of the plate glow? (This plate is filled out for you as an example!)



B. What results would we see if we plated a strain that can only sense autoinducers on the top half of the plate, and streaked a strain with a mutation that prevents it from producing autoinducers on the bottom half of the plate? Which sides of the plates glow?

C. What results would we see if we plated a strain that can sense and produce autoinducers on the top half of the plate, and a strain that can sense autoinducers on the bottom half? Which sides of the plate glow?