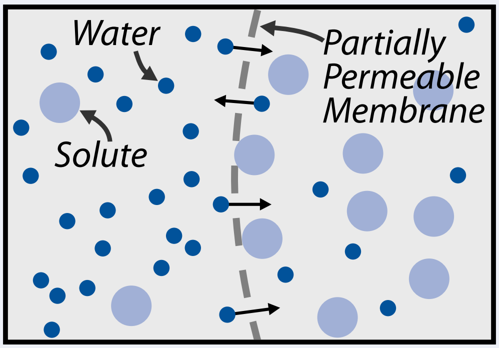
Osmosis in Food

Contrary to culinary wisdom, brining something does *not* draw water into the cells to make it juicier—that would be going against osmosis! Brining draws water *out* from cells and appears to increase the liquid in the tissues around the cells. But what is osmosis?

Osmosis is the physical process of a solvent passing through a membrane to equalize the concentration of solute on the membrane's other side. For example, applying salt to the outside of meat or cooking fruit in sugar syrup causes water to pass from inside the cells through the cell walls and out into the salt or syrup solution to dilute the salt or sugar on the outside. This happens because salt and sugar are unable to penetrate the cell walls, but water can, so water leaves the cells in order to equalize the differences in concentration. (Salt also happens to break down some of the myofibril proteins and thus change the meat's texture—but that's not due to osmosis!)

Osmosis is all about *diffusion*. Molecules dissolved in liquid will distribute themselves out to roughly uniform concentrations, somewhat like steam in a hot shower will distribute itself through a room. (Can you imagine taking a hot shower and having all the steam stay in just the left half of the shower stall?!) The higher concentration on one side of a membrane like a cell wall causes the solute (the salt or sugar) to bounce up against the membrane, creating what's called *osmotic pressure*. If that membrane is permeable to the solute, some of it will pass through to the other side until the pressure of molecules bouncing up against the membrane from both sides is roughly equal.



In cells, osmosis leads to dehydration, and if there's a large enough difference of concentration between the two sides of the cell wall, *plasmolysis* occurs—the cell structure collapses. If too much water leaves, the cell dies. From a food safety perspective, the amount of salt necessary to cause sufficient plasmolysis to render bacteria nonviable depends on the species of bacteria involved and the type of food at hand. *Salmonella*, for example, is unable to grow in salt concentrations as low as 3%, while *Clostridium botulinum* dies at around 5.5%. *Staphylococcus* is hardy enough to survive in a salt concentration up to 20%. However, according to the US FDA, it is not a common concern in fish, so food safety guidelines consider salt solutions of ~6% generally safe for curing fish.

Bread-and-Butter Quick Pickles

Quick pickles are made from cucumbers sliced into thin discs and cured in hot vinegar mixed with spices and sugar. It's the sugar that makes them "bread-and-butter" pickles. They're amazing with their namesake; try them on toasted bread slathered with good butter. Like refrigerator pickles, which are fermented for a few days before refrigeration, these aren't properly preserved for long-term storage—not that I ever manage to keep them around very long.

In a medium saucepan, measure out:

- **2 cups (480 mL) white vinegar (5% acetic acid)**
- **1½ cup (300g) sugar (or brown sugar)**
- **3 tablespoons (30g) sea salt**
- **1 tablespoon (3g) mustard seeds**
- **½ teaspoon (1g) turmeric powder**

Wash **1 pound (450g) cucumbers**—try to get a pickling variety like Kirby, or use slender, more interesting cucumbers than the standard market variety ("Green Blimp"). Trim and discard both ends and then cut the cucumbers into discs, about ⅛–¼" / 0.5–1 cm thick. Add the slices to the saucepan.

Trim and peel **1–2 onions, about ½ pound (~250g)**. Slice them in half, root end to tip, and then slice them into thin half-rings. Add the onion slices to the saucepan.

Optionally add more pickling spices or items to pickle—for example, **peppercorns**, **celery seed**, **a few bay leaves**, **hot peppers sliced into rings**, or **a bunch of garlic cloves cut in half**.

Bring the ingredients up to a boil and simmer them for 5 minutes with the lid on. Longer simmering times will produce softer pickles. Turn the heat off and allow the pickles to cool until it's safe to transfer them to a storage container. Store them in the fridge and use them within a few weeks.

Notes

- *Sea salt doesn't have any iodine or anticaking additives, which cloud up water. It's also half as dense as table salt, so if you substitute table salt for sea salt, adjust the volume measurements accordingly. Try mixing 2 tablespoons (20g) of sea salt into one glass of water and 1 tablespoon (18g) of table salt into a second glass to see the difference in how clear they are.*
- *When I first thought of using pickles as an example of preservation, I thought it'd be easy to explain. Heat, salinity, and acidity all kill pathogens! Turns out, that's not enough. These quick pickles aren't properly preserved, contrary to what many cookbooks and food shows say. Using hot vinegar speeds up how quickly the pickles are ready to eat, but the heat and pH change isn't enough to handle* C. botulinum. *Without a true canning step, these pickles aren't safe for long-term storage, even in the fridge, as the spores from* C. botulinum *are extremely hardy. Treat quick pickles like any other perishable food: keep them refrigerated and eat them within a few weeks.*
- *If you want to make shelf-stable pickles, you'll need to can them. Canning is a good example of multiple preservation techniques being combined: cooking* sealed *jars in hot water removes* Listeria, *and the vinegar drops the pH to a range that* C. botulinum *spores won't germinate in. The pH is critical: it must be below 4.6 because the canning step alone won't destroy bacterial spores. Even changing the ratio of liquid to solids when making pickles can shift the pH! For canning steps for bread-and-butter pickles, see* http://cookingforgeeks.com/book/pickles/. *Tip: you don't need a boiling water canner; use a large pot for boiling the water and a trivet you don't mind getting wet set into the bottom of the pot.*

Why aren't refrigerator pickles actually preserved?

The USDA started studying pickles in the 1930s in its Food Fermentation Laboratory, but even as late as 1989 researchers were still finding issues. *Listeria monocytogenes* was showing up in refrigerator pickles contaminated after cooking. It's not surprising, in hindsight: *L. monocytogenes* survives in liquids with a pH as low as 3, *and* in salt brines up to at least 10%, *and* reproduces at 34°F / 1°C, *and* is odorless and tasteless. (It just wants to live! Inside you!) Because regular spoilage bacteria won't grow in these conditions, infected pickles won't have an off taste or produce any foul-looking stuff. The USDA pulled its recommended recipe for refrigerator pickles, but it's been bouncing around ever since.