

SCIENCE OF COOKING PASTA

Some cooks were taught to watch the pot or the noodles would be horrible. Others were taught to fill a large kettle with water, and then bring that to a boil so there was plenty of water to cook the noodles. Others were told they had to put oil in the pot or the noodles would stick.

Pasta, honestly is a joy to cook. Let's look at the science.

Background: Most adults were taught to use a large pot and a large amount of water to cook pasta. As these older ways were questioned, here are the most common reasons we have found for why to use a large volume of water:

- 🍷 **Reason 1.** A large volume of water has a higher ability to absorb heat, and keeps its temperature better than a small volume of water. When you drop pasta into water, the smaller volume of water will come to a boil much faster than the larger volume. If pasta sits in warm water while bringing it back to the boil, the pasta will become overcooked and mushy.
- 🍷 **Reason 2.** A large volume of water at a rolling boil helps keep the pasta separated from each other. The pieces of pasta need to be constantly stirred (agitated) in the water and thus cook more evenly with fewer clumps.
- 🍷 **Reason 3.** A small volume of water will become too starchy as the pasta cooks. This will make the pasta more sticky when you drain it.
- 🍷 **Reason 4.** That's the way grandma did it.

For reason #1, pasta will cook at any temperature above _____°F. (Come back to this...important fact)

Reason 2 false, constant agitation drives everyone crazy. It is almost not necessary to stir all of the time. Just twice, once when putting pasta in the pot and the next stir is about a minute later.

Reason 3 is false because pasta is drained. That is not the reason for sticky pasta that is gross and clumpy.

Reason 4 doesn't count at all. In this process, there is science!

Pasta is made up of flour, water, and sometimes eggs. Essentially, it's composed of starch and protein. Starch molecules come aggregated into large granules that resemble little water balloons. As starch granules begin to heat up in a moist environment, they absorb more and more water until they finally burst. When this happens the starch molecules blow out into the water. The reason why pasta always seems to stick together at the beginning of cooking is because the starch molecules came out and act as a sort of glue, binding the pieces to each other, and to the pot.

After this stage, the starch eventually washes away into the water (assuming that you separated the pieces of pasta by stirring...agitating), and the pasta pieces become individuals again. As the pasta cooks, the starches gradually absorb more and more water, becoming softer and more edible, while the proteins begin to denature (protein unfolds because of the cooking process), adding structure to the noodle (something that is much more obvious when cooking soft fresh egg-based pastas).

When the stars are aligned, you'll manage to pull the pasta from the water *just* when the proteins have lent enough structure to keep the noodles strong and flexible, and starches have just barely softened to the perfect stage—soft, but with a bite—known as *al dente*.

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Scientific findings #1: the Pot of water

If you take a small pot, a medium pot, and a large pot and placed them on a burner. Add 4-6 cups of water to them and bring them to a boil. Next place equal amounts of pasta in each. Give a quick stir so that the water touches all of the pasta. You can use any pasta for this.

You will find that the larger pot is able to keep the temperature of the water higher after the pasta has been added. This is because there is more surface area of the pot that retains heat. The smaller pot cools the most when the pasta hits the water. Energy is required to keep the heat at a certain point. Adding pasta removes the heat from the water, but not the pot itself.

Scientific finding #2: The water

The water in the largest pot will take the longest to come back to a boil (212°F/100°C). This is because there is more surface area than the smaller pots. Surface area is the amount of the pot that touches air.

Scientific finding #3: Taste

Weigh the pastas cooked in each pot separately. You will find that all pasta absorbed the same amount of water, even though the cooking times may have varied a bit. Even more importantly, they all taste the same. Why is that?

Scientific finding #4: Sticky Pasta

It is true that during the beginning of cooking pasta, if water is brought to a boil, that the starches blow up and stay on the surface of the water. If pasta is just put into the pot and left there, the pasta at the top can get glued together and stick. The key is to “stir the pasta” or agitate it. This rinses the starch off the hard pasta noodle so that it can absorb water and not the gluey substance from the exploding starches and water. The only thing to do to prevent sticking is give the pasta a few good stirs after the first minute or two.

Scientific finding #5: The pasta water changes (transforms)

After the pasta cooks, the water becomes starchy. At the beginning of this whole process, the water is clear. After cooking the pasta, the water has the starch from the pasta in it. This becomes one of the best things in the culinary world. This water holds the secret to making incredible fresh sauces. Reserve some of it for your sauce.

Pasta water has starch granules and water, which is like the Chinese cornstarch slurry used to thicken sauces. Also the starch acts as an emulsifier. Emulsifiers get in the way of tiny fat molecules, preventing them from coalescing. (forming a mass). Fat sticks together, however, in sauces, fat is emulsified into something different. Such as a cream sauce, or a gravy. Thus, Chefsville lists of pasta sauces has references that show the coalescing process.



Scientific finding #6: Don't boil the water

When cooking, starches start to absorb water at temperatures as low as 180°F or so (that's why a cornstarch-thickened sauce will begin to thicken well below the boiling point). Is it actually necessary to have a boil at all? Could I not just make sure my water was above 180°F at all times?

Bring a pot of water to a simmer, then add the pasta. Stir to be sure the pasta is not sticking to itself or to the pot. Place a lid on the pot and shut off the burner. Cook for 10-12 minutes. Check the water temperature to be sure it is kept around 180°F.

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For long shaped pasta, it takes a minute to become soft enough to submerge in the water. Its not necessary to add oil to the water. Oil just floats. Oiling the pasta a bit after it comes out of the pot will create a barrier so that sauces don't stick to the pasta. Sauce the pasta immediately instead of using oil. After the pasta is sauced, then it can have a bit of finishing oil for adding flavor and texture. Do season the water as it makes the pasta taste better. Now go prove this.

Scientific finding #7: Season the water with salt

Between $\frac{3}{4}$ teaspoon up to 1 Tablespoon of fine sea salt per quart will do just fine.



Scientific finding #8: Sauce sticking to the pasta (cohesion)

To harness its maximum powers of **cohesion**, we recommend removing your pasta from its water just as it hits *al dente* and finishing it in a pan with your sauce of choice and a ladleful of starchy water. As the water and sauce mixture reduces, you'll find that it clings evenly to the pasta.



Caution when cooking pasta: How much water goes into the pot?

It does depend upon the size of the noodles, but generally for non-spaghetti like pasta Start out with 4 cups, then add 1 cup per person. 4 to 12 cups should be all you ever need unless you are cooking for a big crowd. Do not over fill the pot with water. At the most, come up $\frac{2}{3}$ full.



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Caution: Prevent “boil-over”

When starch molecules pop, white foam flows to the top. It's the foam layer on top that causes the problems. What has happened is the starch makes the bubbles that were already there more stretchy and pliable. These bubbles take longer for them to burst. Lots of bubbles on the surface doesn't allow for proper ventilation of steam, meaning the pot of boiling water becomes superheated if the pot isn't stirred or the frothy layer skimmed off the top in time. The trapped steam causes the frothy bubbles to expand and pop up, resulting in boiling-hot pasta water all over your stove if you're not careful.



Other tips to prevent boiling over are:

- 🌐 When cooking pasta, don't boil the water at all. It is not necessary. Pasta cooks at 180°F.

But if you must boil the water:

- 🌐 Don't leave a lid on the pasta pot. This makes the starch molecules heat up very quickly. Leaving the top off allows steam and heat to escape more easily.
- 🌐 Leave a wooden spoon lying across the pot. This might seem like an old wives' tale, but it works. Here's how: when the foam bubbles up it will eventually meet the spoon. The foam is thermodynamically unstable, which means when the bubbles reach the spoon they will burst, breaking the layer of foam and sending all of the bubbles collapsing down again.
- 🌐 Use a bigger pot. With higher walls to climb, the layer of foam likely won't be able to bubble over the edges.

Caution: The information here is for dried pasta. Select a cooking pan big enough to accommodate the pasta's shape. If using spaghetti-like length use a wider pot. When using fresh pasta made with egg, please bring water above 190°F.