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Sous Vide Que Made Easy

How To Deliciously Marry The Grill And The Smoker With Sous Vide

With Exclusive New Safety Data

version 2.0

By Meathead & Clint Cantwell

A DEEP DIVE GUIDE FROM
Meathead's AmazingRibs.com

SOUS VIDE QUE MADE EASY

HOW TO DELICIOUSLY MARRY THE GRILL AND SMOKER WITH SOUS VIDE

MEATHEAD

with

CLINT CANTWELL

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Published By Meathead's Deep Dive Guides

Produced by the team at

Meathead's AmazingRibs.com

Version 2.0

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TABLE OF CONTENTS

PART I
ABOUT DEEP DIVE GUIDES

"This is my invariable advice to people: Learn how to cook – try new recipes, learn from your mistakes, be fearless, and above all have fun!"

— JULIA CHILD

Deep Dive Guides is the ebook imprimatur of Meathead's AmazingRibs.com. It is a growing series of ebooks in which

we have attempted to share our breadth and depth of experience on a culinary topic. They are designed to give you an inexpensive deep dive into a topic so you come away knowledgeable and confident. They contain numerous links to pages on the internet and videos. You will enjoy this book best if you read it while you are connected to the internet.

Some of this content is scattered among the 2,000+ pages on Meathead's AmazingRibs.com. Although websites are great references, they are not great learning environments, not nearly as good as books. We think that binding together carefully edited articles in an organized flow from start to finish in book format, is a far better way to learn than from articles scattered around on a website.

Some of this info appears in other Deep Dive guides because we think that it is important that they all contain foundational info on such things as meat science, safety, tools, etc. So we have included the most important info within these pages, and written new, previously unpublished, related info. Enjoy!

PART II
INTRODUCTION

For his birthday in 2003, Meathead's wife bought him a cheap starter smoker and he was hooked after his first slab of ribs. One day, his neighbor, a former butcher, started bragging on his ribs and, always competitive, Meathead challenged him to a cookoff. Then he panicked.

So he went to Amazon to order all the books he could find on ribs and barbecue. To his dismay, there weren't many. Trained as a writer and photographer with some culinary chops, he saw an opportunity. He thought "I'll write a book about ribs!" To get things rolling, he built a website, AmazingRibs.com (because in those days search engines listed results alphabetically). It had one recipe, Last Meal Ribs.

Well it took him until 2016 to get that book off the presses. "Meathead, The Science of Great Barbecue and Grilling" was called "one of the 100 best cookbooks ever written" by

Southern Living magazine, and page 206 has the recipe for Last Meal Ribs.

In the meantime, his website has grown to more than 2,000 pages with hundreds of recipes from steaks to burgers to eggplant parmesan, almost all cooked outdoors, plus lessons on technique, science and mythbusting, as well as unbiased product reviews of hundreds of grills, smokers, thermometers, gadgets, and more.

Then, in 2013 he discovered sous vide. He dove into this relatively unknown method and began crossing the streams, combining sous vide with grilling and smoking. He dubbed the technique "Sous Vide Que" and began writing about it on AmazingRibs.com. His experiments caught the attention of the scientists and chefs who were writing books on sous vide, and when the International Sous Vide Association (ISVA) was founded, he was invited to present a paper to the conferees and cook dinner for them. He did 500 steaks and seared them on three charcoal chimneys, his now famous "afterburner technique." It was a 100°F day, and that's the story of the cover photo of this book, tongs in one hand and beer in the other.

Devour this book and you will emerge with the expertise to create this holy grail of backyard BBQ and family and friends will worship you. Be amazing!

ABOUT MEATHEAD

Meathead points at baby front ribs

Meathead is the barbecue whisperer, hedonism evangelist, and mythbuster who founded **Meathead's AmazingRibs.com**, by far the world's most popular outdoor cooking website. He is a BBQ Hall of Famer and the author of "**Meathead, The Science of Great Barbecue and Grilling**", a *New York Times* Best Seller that was also named "One of the 100 Best Cookbooks of All Time" by *Southern Living* magazine, one of "22 Essential Cookbooks for Every Kitchen" By **SeriousEats.com**, and one of the "25 Favorite Cookbooks of All Time" By **Christopher Kimball's Milk Street**.

He was previously a syndicated wine critic for the *Washington Post* and *Chicago Tribune*. He has taught at Cornell University's School of Hotel Administration in Ithaca, NY, and Le Cordon Bleu in Chicago, and he has judged food, wine, beer, and spirits around the world. He lives in the Chicago area with his wife, a PhD microbiologist and a food safety expert, so if you dine at his house you will eat and drink well, and safely.

CLINT CANTWELL

Clint Cantwell is AmazingRibs.com's Senior Vice President, charged with creating recipes, writing

articles, shooting photos, marketing, and a little bit of everything else.

With a passion for all things barbecue and grilling, Cantwell was named one of the “10 Faces of Memphis Barbecue” by *Memphis Magazine* in May 2015 and was the winner of the Travel Channel's “American Grilled” nationwide cooking competition series. He came to AmazingRibs.com from Kingsford.com where he served as editor for several years. He is also the pitmaster of Smoke in da Eye competition barbecue and grilling team.

From his childhood in Texas to years in Kansas City, Wisconsin, New Orleans, and New York, Cantwell's passion for barbecue and grilling runs deep as he travels the country in search of the people, places, and tastes that define our shared cooking culture. He lives just outside of Memphis with his wife, three children, and Charcoal the dog, sharing his grilling and smoking ideas, experiences, recipes, tips, techniques and more.

SPECIAL THANKS TO

Clint Cantwell, Senior VP and author of some of our favorite recipes, a few of which are on these pages

David Joachim, Executive Editor of Meathead's AmazingRibs.com

Prof. Greg Blonder, Science Editor of Meathead's AmazingRibs.com

Brigit Binns, cookbook author, educator, editor

Chef David Pietranczyk, PolyScience Culinary Support Manager

Joule for photos of their product and the two charts in the chapter "Sous Vide's Just Another Way To Go Low And Slow."

Anova, **Lipavi**, **Food Saver**, and **Amazon** for photos of their products.

And the rest of the team

ABOUT MEATHEAD'S AMAZINGRIBS.COM

Called "*By far the leading resource for BBQ and grilling information*" by Forbes, Meathead's AmazingRibs.com is all about the science and art of barbecue, grilling, and all forms of outdoor cooking. With more than 2,000 pages of free information, the site offers countless thoroughly tested recipes, tips on technique, original science research, myth-busting, and unbiased equipment reviews.

The site ranks among the most popular food websites in the US and is one of only a small number of sites in the Library of Congress' Food and Foodways Web Archive. Other sites in the archive include the Food and Agriculture Organization of the United Nations, James Beard Foundation, Southern Foodways Alliance, Jose Andres, US Food & Drug Administration, Oxford Symposium on Food & Cookery, and Seafood Watch. We are in good company!

The site has numerous extraordinary features, among them the world's largest collection of grill and smoker reviews by the world's only full-time grill and smoker tester, the

world’s largest collection of thermometer reviews and test results by an electrical engineer, a unique curing calculator, a salt conversion calculator, and it specializes in using science to bust scores of barbecue and grilling myths.

ABOUT THE AMAZINGRIBS.COM PITMASTER CLUB

The **AmazingRibs.com Pitmaster Club** is the world's largest barbecue association with more than 17,000 paid members who enjoy a lively community forum and more than 20 cool benefits to membership including monthly drawings with prizes worth up to $2,000. You are invited to take a free 30-day trial membership. No credit card necessary. Click here **https://AmazingRibs.com/pitmaster**

Here are some of the 20+ benefits to membership:

- You support **AmazingRibs.com** and help us grow
- We block all third party ads from members
- Free $9.95 Food Temperature Guide Magnet with 80+ benchmark temps
- Free ebooks
- Free sneak preview of **The Meathead Method**, Meathead's next book in progress
- Free **Barbecue News** magazine every month
- Free **Tailgater** magazine
- Exclusive recipes, recipes, recipes
- 3 monthly giveaways worth up to $3,000
- Exclusive audio and video content
- Cartoons
- Great discussions and debates with knowledgeable moderators and no race, religion, or politics flamewars allowed
- 3 informative monthly email newsletters
- Meat-Ups
- Discounts on products we love
- Members can buy cool embroidered Pitmaster Club bowling shirts or inexpensive T-shirts
- Membership certificate
- Support for Operation BBQ Relief
- Support for Global Alliance for Clean Cookstoves
- Easy Autorenewal

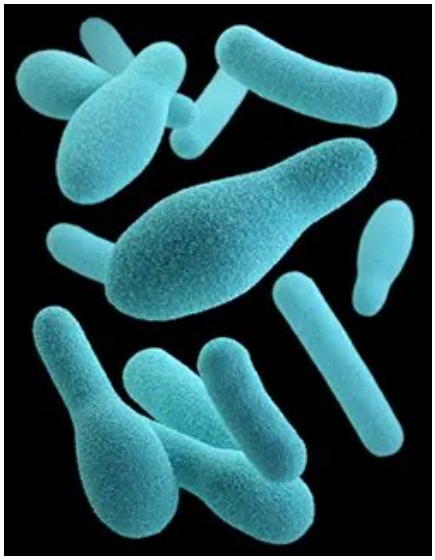
STAY IN TOUCH

Have a question? Meathead and the site's knowledgeable moderators answer reader questions promptly. Just go to Meathead's AmazingRibs.com and post your question on any page at the bottom where it says "Click for comments..."

If you find an error or a broken link in this book, please let us know here.

And be sure to subscribe to Smoke Signals, our free monthly email newsletter with links to new articles and reviews and more.

PART III
SAFETY FIRST



Fire, knives, pathogens, oh my! People can die from improper cooking. But the risk is very low with a little common sense and an ounce of prevention.

SPOILAGE

There are two types of spoilage: Oxidation and Microbial.

Oxidation is caused by compounds in meat, especially animal fats, combining with oxygen and changing the meat's smell, flavor, and color. Badly oxidized meat is called rancid. The good news is that oxidized meat is usually not dangerous.

Microbial spoilage is the other type of spoilage, and it is very dangerous. There are several commonly occurring *bacteria* and *viruses* in food that can spoil it. Some of these bad guys will merely have you kneeling before the porcelain god, but others can maim or kill you. The goal is to pasteurize the food, i.e. kill as many bugs as possible so that it is safe. That's different than sterilizing which kills every single microbes. We can easily *pasteurize* at home. *Sterilization* is a method that kills or removes all microbes and their spores by using one or more of the following: Heat, irradiation, chemicals, pressure, or filtration.

You can pasteurize most meats by cooking them to 131°F interior temp and holding it for two hours. At 165°F interior, bacteria are killed instantly. **For more on bacterial kill temps, click here and scroll down**.

BACTERIA

The Center for Disease Control (CDC) estimates that in one recent year roughly one in six Americans got sick from food, 128,000 were hospitalized, and 3,000 died. *The bad guys are certain types of bacteria, viruses, and parasites.* If you don't want the details, let's make it easy:

Cooking kills the bad guys. Cook food properly and you have nothing to worry about. Raw food is just plain riskier. All raw food and that includes salads.

Bacteria are everywhere. There are more microbes in your body than all other cells combined and they may weigh up to three pounds. **The biggest risks in food come from bacteria you ingest.** Most bacteria are friendly and many, called *probiotics*, are beneficial. Alas, some of them, called *pathogens*, are not so friendly, especially *Bacillus cereus, Campylobacter jejuni, Clostridium botulinum*, *Listeria monocytogenes, Salmonella, STEC (Shiga toxin* producing *E-coli*), *Shigella, Staphylococcus aureus*, and *Vibrio*. They are hard

to trace because they can often take a day or more to grow in your gut before they knock you down, so figuring out what it was in the fridge or if it was the restaurant lunch is hard to do.

VIRUSES

Viruses are not a major threat in food with one notable exception: *Hepatitis A* virus (HAV) a.k.a. *norovirus* usually comes from human fecal matter, often as a result of poor hand washing.

Coronavirus/COVID-19 is primarily a respiratory virus. It mostly infects the nose, throat, and lungs. Almost all infections come by inhaling droplets of moisture from the breath of other people who have been infected. The risk is greater the more viruses you inhale. The risk can be lowered by limiting your proximity to other people and by using a mask. Normal painter's masks can prevent you from spraying and can reduce the amount of spray you inhale, but they can't stop all the viruses. Masks labeled N95 are much more effective. That's what doctors prefer.

You can get sick by touching something that has the virus on it such as a grocery cart or an apple, and then transferring it to your respiratory system by touching your eye or the inside of your nose or mouth, or by eating food handled by someone who has the virus. The data says the risk of getting sick is low from touching things, especially if you wash your hands often, and keep them out of your eyes, nose, and mouth.

Food is not a likely carrier even if you eat with your hands. If the preparer is sick and washed his or her hands and didn't sneeze or cough on the food, there is likely to be no viruses or at worst a very small load (quantity of bugs). Keep in mind that food goes down one pipe and air down another so if the food is contaminated, it is possible it could get into your lungs because you breathe when you eat, but the risk is considered to be very very low.

PARASITES

Raw food can harbor parasites, most commonly adult tapeworm, tapeworm eggs, tapeworm larvae, and toxoplasma. Tapeworms are most commonly found in seafood. Cooking to 145°F will kill adult tapeworms as well as larvae and eggs. That is hotter than most chefs like to cook fish, even with conventional cooking. Fortunately, most parasites can be killed by freezing for 7 days at -4°F or for 15 hours at -35°F. Commercially frozen fish are often taken to these low temperatures. Alas, most home freezers are set to 0°F. So if you wish to cook fish to 131°F or below, you should consider buying commercially frozen fish.

Toxoplasma is found in shellfish and some mammals as well as contaminated water and cat litter. Fortunately toxoplasma is killed by freezing or cooking.

HOW DO FOODS GET CONTAMINATED?

That's quite a rogues gallery of potential contaminants. If you ingest enough bacteria, they can leave you sitting on the

toilet for hours, plant you on your knees in front of the porcelain god, send you to bed in a sweat and writhing in pain for months, propel you to the emergency room, or even the cemetery. Children and elderly are especially at risk.

It is helpful to think of all raw food as kryptonite. Of course most is perfectly safe, but you never know, and trusting your butcher is no guarantee because most contamination happens long before it hits his loading dock. And although fruits and veggies are not as frequently contaminated, if you pay attention to the news, you will know that recalls of lettuce, spinach, chili peppers, melons, sprouts, and strawberries are frequent because we eat them raw. Contaminated meats are decontaminated when we cook them properly.

The most common source of contamination is animal waste, and that includes human animals. If the bad breeds of E-coli get into water that is used for irrigation, if organic fertilizer is not sterilized properly, if Bambi or Thumper have lunch in a field of lettuce, if a steer's intestines are accidentally sliced open in the slaughterhouse, or if your butcher didn't wash his hands after using the toilet, we have a problem.

If a bluebird bombs a strawberry, if the henhouse isn't cleaned properly by a minimum wage teenager, if the water bath used to remove the feathers from chickens isn't disinfected, we have a problem.

Egg shells may look impervious, but if the hen has salmonella, it can get into the ovum before the shell hardens.

Raw fish sushi is silky and elegant, unless tapeworm eggs from seals, walruses, or whales get into your salmon. They can grow up to 60 feet inside a human.

Raw sprouts might seem like health food, but if Tweety decides to visit the alfalfa seeds or if rodents and insects nibble through the burlap shipping bags in the hold of a ship or warehouse, when we soak and warm the seeds to sprout them, we also water and warm the pathogens. **That makes sprouts the most dangerous food in the super market.**

Improper food handling also makes contamination from your hands, cutting boards, and knives a major problem.

MAKING FOOD SAFE

The most effective way to make food safe is to cook it properly. Raw food, of any kind, is always a risk. In the language of food safety scientists, you need a "kill step" in the process. Lemon juice, vinegar, alcohol, salt, and freezing will not pasteurize food. They may kill a few bad guys and hamper their growth, but they absolutely positively cannot be trusted to make food safe. Sorry, but they just don't get the job done. Acid and salt might inhibit growth, but they won't make your food or countertop safe. Remember, when research labs want to store their microbes, they freeze them.

To cook foods properly you must use a digital thermometer. Cooking without it is like driving at night without headlights. AmazingRibs.com has an electrical engineer who tests, reviews, and rates thermometers. His database of more than 200 is a valuable shopping guide. We do not sell any.

The excellent thermometer shown here, the Thermoworks Thermopop reads accurately in 5 seconds and sells for less than $30. **Click here to order it**.

A hot dishwasher and its detergent will make dishes and utensils safe. For countertops, cutting boards, knives, meat grinders, and other things that can't go in the dishwasher, chlorine bleach is your go-to sanitizer. That's why they put it in swimming pools.

You don't want to wash down your carrots with a poison. But chlorine is an excellent disinfectant for cutting boards, countertops, knobs, and handles. Buy an empty spray bottle at the drug store and fill it with a dilute solution of household bleach.

USDA recommends a solution of one tablespoon of 5% unscented, liquid chlorine bleach per gallon of water. After washing with warm soapy water, sanitize with bleach. Wet the surface with the bleach solution and allow it to stand for several minutes. Rinse with clear water and air or pat dry with clean paper towels. Store the solution in the bottle, tightly sealed, and use it often.

STORING RAW MEATS

Can you imagine life without refrigeration? We would eat only what we killed today, or we would all be vegetarians, or we would all be experts on pickling and canning.

But you cannot keep meat in the fridge or freezer forever. Even at standard refrigerator temp, 40°F, 3 to 5 days is the longest you should keep raw meat. Keep in mind, many meats you buy may have already been stored in grocery for several days. So it is best to cook meats soon after you get them home or freeze them. Meat kept in the fridge can still host and grow dangerous microbes, so just because it is chilled doesn't mean it is safe. Cooked meats, if wrapped well, can be kept for up to a week in the fridge before they get risky.

Frozen meats stay good longer. At standard freezer temperature, 0°F, most dangerous microbes cannot grow, so frozen meat can be safe for many months. But remember, freezing does not kill microbes. Oxygen in the packaging can change the flavor and texture of the meat, and the cold can

freeze dry it. When wrapping meat for the freezer, get out as much air as possible wrapping it first with form fitting plastic wrap. If you can, use a vacuum system to suck out the air.

Ground meats have more oxygen mixed in so they start tasting funny sooner than steaks. Pork gets funky faster than lamb which gets funky faster than chicken or turkey, and beef is the last to go.

In general, the bigger the hunk of meat, the longer it will keep. Here's a rough guide that can vary depending on how well you have wrapped the meat:

- **Ground pork and sausage:** 2 months
- **Ground beef or lamb:** 4 months
- **Pork chops:** 4 months
- **Pork roasts:** 5 months
- **Lamb chops:** 5 months
- **Steaks:** 6 months
- **Beef roasts:** 8 months

Why is meat in my fridge turning brown?

At first, oxygen reacts with pigments to turn meat red. After a while, the meat starts to oxidize, which turns it brown, the same way an apple or potato turn brown.

Why does my meat shine like a rainbow?

It is simply a fluke of lighting that strikes the surface just the right way when the surface has been cut on a certain angle. Strictly refraction, not bacteria or an oil slick.

Why is my meat green?

Bad bacteria. Throw it out.

Why are there are dry white spots on my meat from the freezer?

That's freezer burn. It's like frostbite. The meat has probably been in the freezer too long and/or it was not wrapped tight. It is still safe, but the burned parts will probably be dry and bland. Trim it off and cook it, but don't serve it to Mom or the boss.

My meat smells funny, what should I do?

Sometimes meat will smell a bit odd when you take it out of a vacuum sealed plastic bag, but the smell should dissipate within a few minutes. If it still smells funny, then chances are it is funny. Throw it out. Remember: when in doubt, throw it out!

What are those boogers coming out of my burgers and my salmon?

According to the AmazingRibs.com meat scientist, **Dr. Antonio Mata**, hamburger exudates (I call them boogers) are proteins dissolved in water, mostly myoglobin. When burgers are ground, plump muscle fibers are sheared open. As the meat begins to heat, protein and collagen shrink and squeeze out the proteinaceous fluids, which are pink at first, and then they gel and turn tan just like the meat.

In salmon, boogers consist of another group of proteins dissolved in water called *albumin*. The albumin is pushed to the surface by shrinkage caused by heat. Brining helps minimize it, but not always. Salmon boogers can usually be wiped off with a paper towel or a brush. Another good technique is to paint the surface with a simple wash of sweet wine, mirin, or a glaze.

WASHING FOOD AND CUTTING BOARDS

Rinsing meat can remove slimy fluids on the surface, but these are really nothing much to worry about. To be sure there are bacteria in them, but they will be killed instantly when heated. Rinsing is helpful to remove bone chips that might be on the surface from the butchering process because many cuts through bone are made with band saws.

Unfortunately, rinsing meat in the sink cannot remove bacteria which are embedded in the pores and cracks in the muscle surfaces. In fact, rinsing can make things worse by splattering microscopic contaminated droplets onto the sink and counters.

Jennifer Quinlan a food safety scientist at Drexel University in Philadelphia did some famous research in which she showed that rinsing meat aerosolizes tiny droplets of juices laden with bacteria all over the sink, faucet, surrounding counters, dish drains, and yourself.

Although she doesn't discuss it, the problem also arises in washing your cutting board.

She recommends you do not wash meats. But we know you want to. The solution is to turn down the water pressure and be careful not to splash. Or submerge the meat or cutting board in water.

HAZARDOUS FOODS

FOOD ALLERGIES

The Food Allergen Labeling and Consumer Protection Act requires that food packaging must declare prominently if it contains any of the eight most common food allergens: Milk, eggs, peanuts, tree nuts, fish, shellfish, soy, and wheat.

A good host will always ask guests in advance if they have any food allergies and either plan a menu that omits them, or plan a special dish for the guest with the allergy. Of course it is also the guest's obligation to inform the host so when dinner is served the host doesn't feel bad that the guest pushes away the plate.

The whole thing gets a bit complicated when people who don't have an allergy or celiac disease, but they have decided to avoid gluten or another food that they think is bad for them.

Common sense, courtesy, tolerance, and communications need to be the watchwords.

OTHER HAZARDOUS FOODS

So a food safety expert from the FDA was giving a seminar on food safety at a culinary school. Near the end of the talk she touched on the fact that some foods have effects that are cumulative and the hazard might not be evident for decades. She asked the audience if they could think of an example. After a few moments of silence an old codger in the front row raised his hand and mumbled “wedding cake.”

KNIFE SAFETY

Be alert and focused when using knives and sharp objects. Beverage alcohol and knives is a dangerous combo.

- Use sharp knives.
- Do not gesture and waive with knives in your hands.
- Always use a cutting board. Never cut anything in your hand.
- A damp towel or paper towel under a cutting board can help keep it from shifting.
- Make sure you have plenty of elbow room when cutting.
- If you drop a knife, get your feet out of the way and don’t try to catch it! Wait for the knife to stop moving before trying to pick it up.
- Never open cans with a knife. I don’t care what you saw on Iron Chef.
- Never use a knife as a screwdriver.

GRILL, SMOKER, OVEN, AND STOVETOP SAFETY

Grills, smokers, sideburners, and indoor ovens and stovetops can do massive damage to property and life if not treated with respect

- Never cook with grills or smokers indoors or in garages. They produce invisible carbon monoxide and smoke that can kill you.
- Don't keep your grill next to a furnace air inlet or even a window. The house is often under a negative pressure, and can suck in these killing gases.
- Don't keep your grill close to your house or deck railings. Beware of overhanging roof lines or trees.
- Never use gas, paint thinner, solvents, or kerosene to start your charcoal. **Chimneys or electric coil starters are the best way to start coals**, but if you use charcoal starter fluid, once the coals are smoldering never squirt them with more fluid. The flame can climb up the stream and set you on fire.
- Don't cook near gasoline or other flammables. Keep propane tanks at least two feet from the burners

unless there is shielding.

- On gas grills, always lift the lid when you ignite the burners. If you have one burner lit and want to add others, it is safe, just open the lid. A gas buildup under the hood could blow it open and flash in your face.
- On kamados and eggs, the lid seal is very tight so when you open it, air rushes in and it can flash flame in your face. Stand back and open the lid slowly.
- Store propane cylinders outdoors in an upright position.
- If you smell gas, turn off the grill immediately. On New Year's Day 2013 ESPN host Hannah Storm returned to the air with a bandaged hand, a wig, false eyelashes and eyebrows. She was injured when trying to ignite her propane grill after the wind blew the flame out. Unbeknownst to her, the gas continued to course through the jets and pooled in the lower chamber because it is heavier than air.
- Handle hot grills, coals, and hot liquids with respect. Be alert. No horseplay near cookers.
- Keep children and pets away from grills and smokers, uncooked meat, hot liquids, and sharp objects.
- Use potholders and/or insulated gloves.
- Do not discard ash until the coals are thoroughly dead. Let them sit overnight or dump water on them before you put them in your trash can.
- Bare feet, sandals, flip-flops, and loose clothes are dangerous around grills.

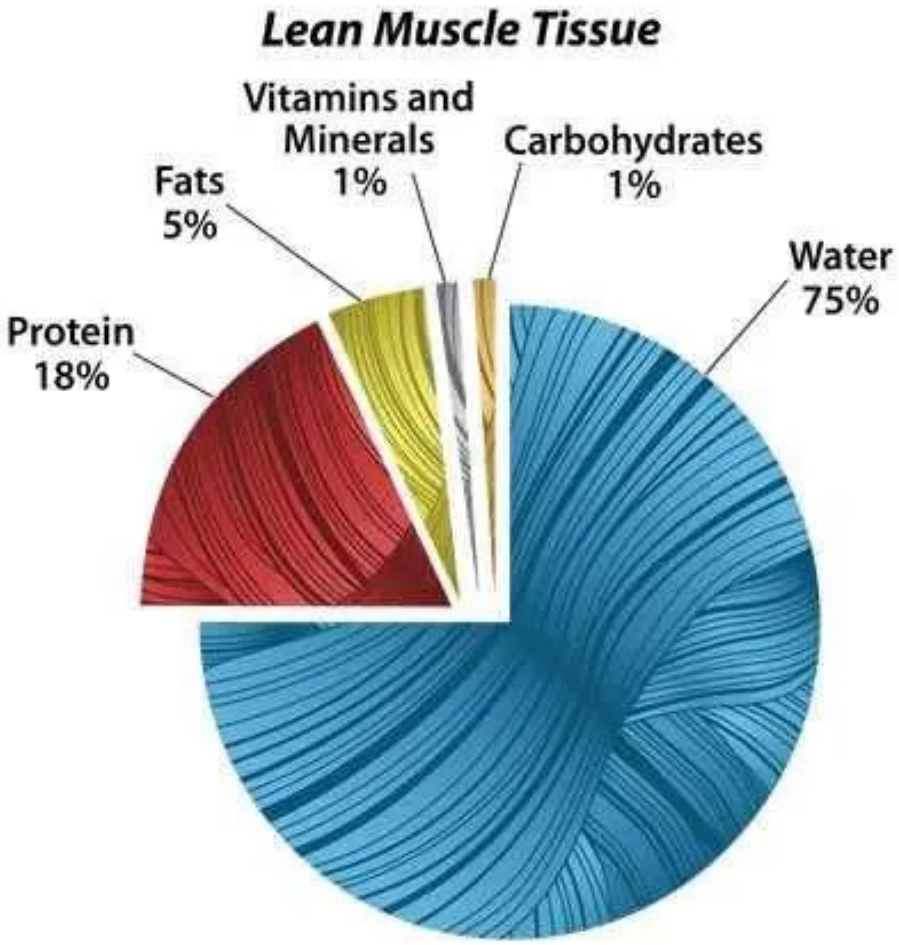
- Don’t put small grills on flammable surfaces or glass tables.
- Before you use a new grill or smoker, fire it up on high and let it run for about 30 minutes to burn off any oil or grease or packing materials from the manufacturing process or from shipping. Click here to read more about **Seasoning and Calibrating a New Grill or Smoker.**
- Save the grill manual and remember where you put it.
- If you have long hair, tie it in a pony tail. And grilling is yet another great excuse to not wear a tie.
- If you pour water over hot coals, it will produce enough steam to melt your nose, and enough hot water will come out of the bottom to melt your toes.
- Heat the grates to high before cooking and carbonize grease and scraps from your last cook. Then scrub them off (read **more about grate cleaning**). If you use a wire brush, beware that bristles can come out and people have died from wire bristles that lodge in their digestive system. Before the food goes on, use a damp cloth and tongs to wipe off the grates and visually inspect them.
- Make sure handles of pots and pans are not sticking out over the edge of a table or counter where people walking by can bump them.
- Do not fill pots to the brim. Liquids expand when they are heated.
- If you put a wet liquid into hot oil it will spit hot oil at high velocity right at your eyes with deadly accuracy.
- Keep pets away from the front of the stove.

PART IV
SCIENCE

Whenever you set foot in the kitchen or sidle up to the grill or smoker, you commence a chemistry and physics experiment. Food is a complex chemical compound and when you apply energy in the form of heat you are using physics to alter its chemistry. As scientific as these processes are, they are also magical!

We could just feed you a bunch of recipes and techniques, but if you understand the chemistry and physics, well, you really don’t need any recipes!

MEAT SCIENCE



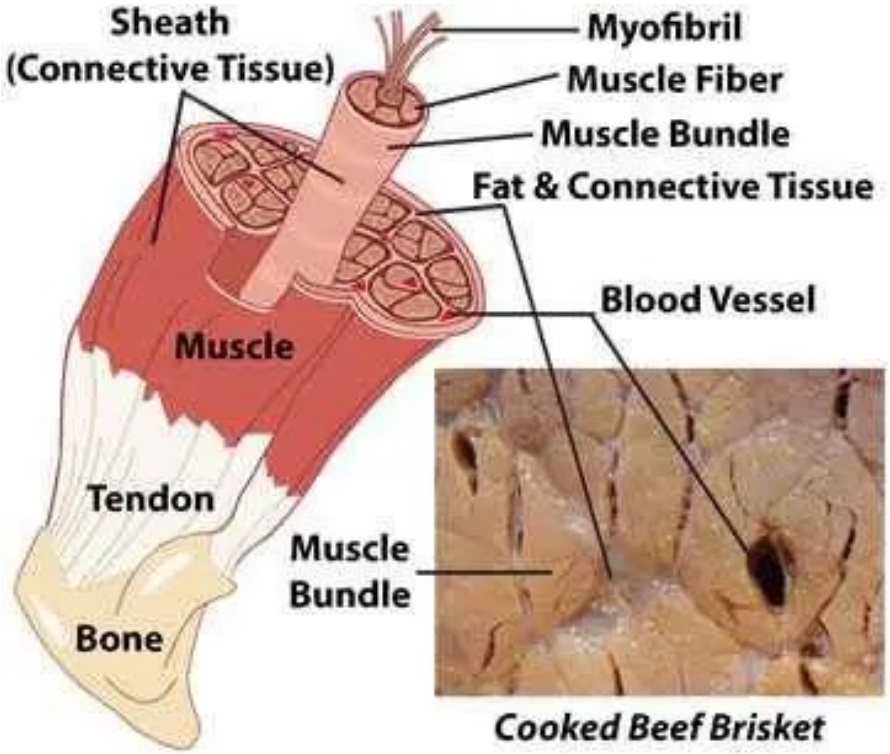
Meat is cut from the muscles of mammals and birds. For some reason, fish muscle is not

considered meat by some people, but it should be. It is fish muscle tissue.

On average, lean muscle tissue of mammals typically breaks down like this: Water (about 75%), protein (18%), fats (5%), carbohydrates, salt, vitamins, sugars, and minerals (2%).

MUSCLE CELLS

Muscle cells are more frequently called *muscle fibers* because they are shaped like tubes. Muscle fibers bundled together are called *sheaths*, and sheaths bundled together are called *muscle or meat.*



The fibers, about the thickness of a human hair, contain several types of protein, among them *myosin* and *actin* which

bind up water and act like living motors by contracting and relaxing on command by nerves. As an animal ages, grows, and exercises, its muscle fibers get thicker and tougher.

Myoglobin is another important protein in muscle fibers. Myoglobin receives oxygen and iron from *hemoglobin* in blood, fuel necessary for muscles to function. Myosin and actin are not water soluble, but myoglobin is water soluble, and myoglobin is the protein in meat that makes it appear red.

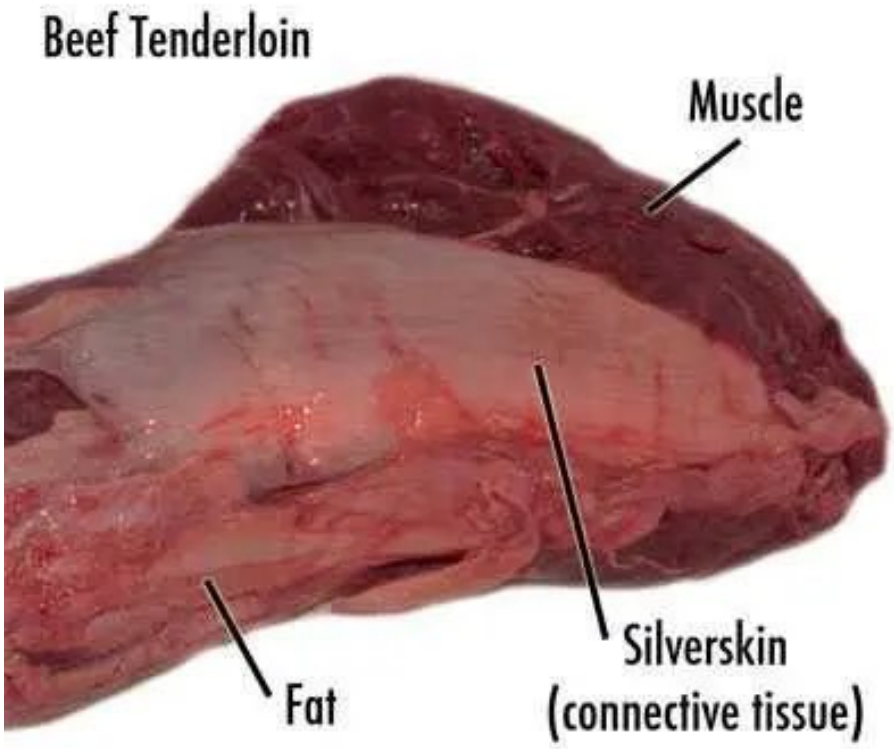
That's right, the reddish color in meat and its juices *is not caused by blood.* It is myoglobin dissolved in water, called *myowater*. Myoglobin is found only in muscle, not in the blood stream. The blood is pretty much all drained out in the slaughter house. If the stuff on your plate when you sliced a

steak was blood, it would be much darker, like human blood, and it would coagulate, like human blood. If the fluids were blood, then pork and chicken would be dark red. It's mostly just water, so let's stop grossing out our kids, and just call it juice. OK? **Every time you call meat juices blood, a bell rings and a teenager becomes a vegan.**

On average, beef has 8 milligrams of myoglobin per gram of meat, **according to the meat scientists at Texas A&M University's Department of Animal Science**, making it one of the darkest red meats. Lamb has about 6 milligrams per gram, pork about 2 mg/g, and chicken breast about 0.5 mg/g. If pork is the other white meat, lamb is the other red meat. When warmed, meat juices containing myoglobin lose their red color, become lighter pink, and eventually tan or gray.

Most of the liquid in meat is water. When animals are alive, the pH of the muscle fibers is about 6.8 on a scale of 14. The lower the number, the higher the acidity. The higher the number, the more alkalinity and less acidic. At 6.8, living muscle is just about neutral. When the animal dies, the pH declines to about 5.5, making it acidic. At this pH, muscle fibers form bunches and squeeze out juice, called purge, and that is the juice you see in packages of meat that is absorbed by the diapers that butchers put under the meat.

Muscle fibers also contain other proteins, notably, enzymes. **Enzymes play an important role in aging meat**.



CONNECTIVE TISSUE

Connective tissue is most obvious in the form of tendons that connect muscles to bones and in ligaments that connect bones to other bones. It is also visible as the thin shiny sheathing that wraps around muscles called silverskin or fascia. These tougher, chewier, rubberband-like connective tissues are mostly *collagen* and *elastin* (as opposed to the muscle, which is mostly *myosin*.) We call them gristle and they shrink when heated and become hard to chew. As with muscle fibers, connective tissues thicken and toughen as an animal exercises and ages.

A softer connective tissue called *collagen* is scattered throughout the muscle, often surrounding fibers and sheaths

holding them together. And yes, this is pretty much the same stuff the Hollywood wives have injected into their faces to get rid of wrinkles.

When you cook, collagen melts and turns to a rich liquid called *gelatin*, similar to the stuff Jell-O is made from. Cooked muscle fibers, no longer bound together by collagen, are now uniformly coated with a soft, gelatinous lubricant. This smooth and sensual substance enrobes meat in a wonderfully silken texture and adds moisture.

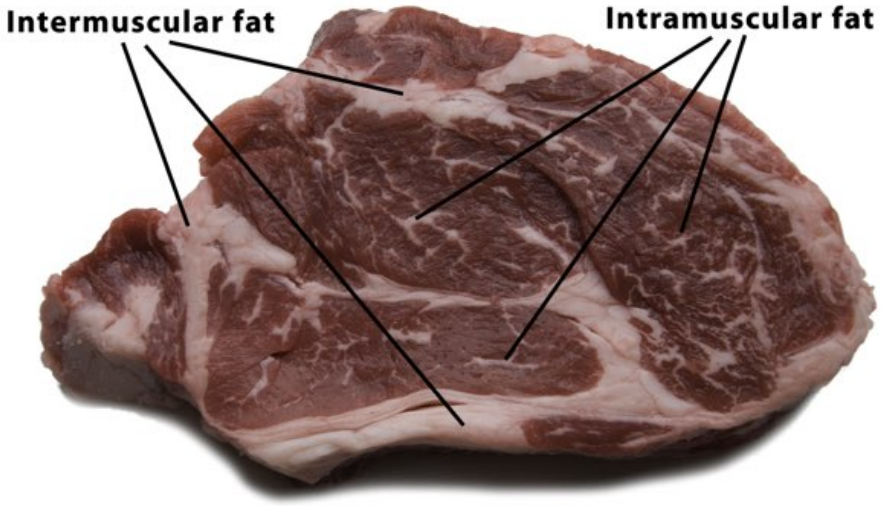
Lean meats such as beef or pork tenderloin, as well as most chicken and turkey, don't have much collagen. When cooking tough cuts of meat with lots of connective tissue, like ribs, brisket, and shoulder, it is important to liquefy the meat's connective tissue into gelatin: that's what makes these tough meats taste tender. This takes time. That's why these cuts are often cooked low and slow.

Muscle fibers start seizing up around 125°F to 140°F if heated quickly. But when heated slowly, the rubber band-like connective tissues have time to relax and do not squeeze tightly. In general, we believe it is best to cook all meats at about 225°F. Slow roasting does wonders for meat. The AmazingRibs.com science advisor **Prof. Greg Blonder** says "Think of silly putty. Pressed hard and quickly, it acts like a rigid solid. Pressed slowly, it flows." When heated slowly, the muscle fibers, instead of wringing out moisture, relax and simply let water linger inside until evaporation drives it out.

After it melts, as it chills, gelatin can solidify into that jiggly stuff which, with a little filtering, can then be called aspic and served at bridge clubs. Here's a pot of the stuff made simply by boiling a couple of chicken carcasses in water after I ate the meat, discarded the bones, and chilled the liquid. The white is fat, most of which I have removed, and the tan is jiggly gelatin.

FATS

Fats (*lipids*) and oxygen are the main fuels that power muscles. Fats are packed with calories, which are potential energy released when the chemical bonds are broken. From a culinary standpoint, fat comes in three types:



- **Subcutaneous** fats are the thick hard layers beneath the skin.
- **Intermuscular** fats are layers between muscle groups.
- **Intramuscular** fats woven amongst the muscle fibers and sheaths improve meat's moisture, texture, and flavor when cooked. These threads of intramuscular fat are called marbling because they have a striated look similar to marble.

Large fat deposits can also be found around organs, especially kidneys. On hogs, the best fat of this type, at least from a culinary standpoint, especially if you make pie crusts, is called leaf lard, and it comes from around the kidneys.

Fats are crucial to meat texture. Waxy when cold, fats start to melt around 130°F to 140°F, lubricating muscle fibers just as they are getting tougher and drier from the heat. Fat does not evaporate like water when you are cooking.

Fat also provides much of the flavor in meat. It absorbs and stores many of the aromatic compounds in the animal's food. As the animal ages, those flavor compounds build up and get more noticeable. After the animal is slaughtered, the fat can turn rancid if stored too warm, too long, or in contact with oxygen. So we have a tradeoff. The muscle fibers and connective tissues get tougher as the animal ages and exercises, while the fat accumulates and builds flavor.

Fats, especially animal fats, are the subject of great debate among scientists, doctors, dietitians, and health faddists. For many years, animal fats were thought to be dangerous and avoided. It is now thought that fats, even animal fats, contain many beneficial components, and current science argues that, in moderation, they are essential for health. A great deal of interesting research on the subject is going on as we write this. A great deal of research is contradictory. **Read more about what we have learned about food and health in this article**.

SLOW TWITCH VS. FAST TWITCH MUSCLES

Muscle fibers need fat and oxygen for fuel. Fat comes from fatty acids in the animal's blood that were created by digestion of its food. Oxygen is carried by the protein *hemoglobin* in the bloodstream, and it hands the oxygen to myoglobin within the muscles.

In general, the more exercise a muscle gets, the tougher it is, and the more oxygen-laden myoglobin it needs. Myoglobin turns meat darker and makes it more flavorful. Dark meats,

like beef, lamb, duck, and goose, are made of “slow twitch” muscles that have evolved to endure slow, steady movement, and they are loaded with juicy myoglobin. Dark meats also have more fat for energy.

White meats, like chicken breasts, are mostly “fast twitch” muscles, which are better suited to brief bursts of energy, and they have less myoglobin. Chicken legs are slow twitch, and even though they are not red, they are darker than breasts. When cooked, the slow twitch muscles in dark meat have more moisture and fat and are more flavorful than white meat. White meats contains less moisture and fat, and they dry out more easily when cooked. Poultry gets more exercise standing and walking than flying, so the legs and thighs have lots of slow-twitch muscles, more pigment, more juice, more fat, and more flavor. They are also slightly more forgiving when cooked. Modern chickens and turkeys have been bred for large breasts because white meat is more popular in this country (and we can’t understand why). We’ll take tough and flavorful over tender and mild any day.

Ducks and geese excel at flying and swimming, and they get more exercise than chickens and turkeys, so these birds have more dark meat. Duck and goose breasts are deep purple, almost the same color as lamb or beef.

When the conventional wisdom was that dietary fat could cause heart and arterial problems, domestic pigs were bred to have less intramuscular fat. The modern pig does not get much exercise due to its transmogrification into “the other white meat.” In recent years, research has questioned the

relationship between dietary fat and health, and many experts now extol fat's benefits.

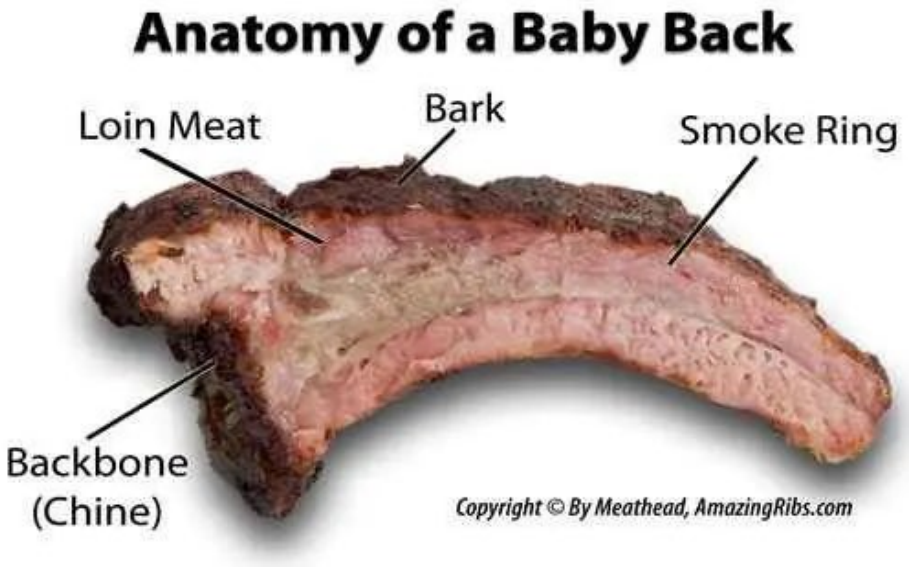
Beef is all pretty much the same color, but slow twitch muscles like flank steak have bigger, richer flavor than some of the lesser used muscles like tenderloin.

Fish live in a practically weightless environment, so their muscles are very different. Fish muscles have very little connective tissue, and that's one reason why fish never gets as tough as pork when cooked. But fish can dry out because there is not much collagen to moisturize the muscle fibers. The color and texture of fish varies depending on the life it leads. Small fish that swim with quick darting motions have mostly fast-twitch muscles and white meat, while flounder, which lives on the sea floor, has delicate flaky flesh. Torpedos like tuna and swordfish swim long distances with slow steady tail movements, so they have have firmer, darker, sometimes even red flesh. For these reasons and others, fish can spoil within days of being caught, while red meats keep much longer.

BROWN IS BEAUTIFUL, BLACK IS BAD

As meat cooks, the most magical transformation that occurs is the *Maillard reaction*. It is named for a French scientist who discovered the phenomenon in the early 1900s. The surface turns brown and crunchy and gets ambrosial in aroma. Who doesn't love the crispy exterior of a slice of roast beef, the browned crust on freshly baked bread? We don't think twice about it, but that brown color on the surface is the mark of hundreds of compounds created when heat starts changing the shape and chemical structure of the amino acids, carbohydrates, and sugars on the surface of the meat. If there is sugar in the rub or marinade it can undergo a flavorful transformation called *caramelization*. Click here to learn more about the **Maillard reaction and caramelization**.

What you don't want is black meat. Let it go too far and it turns to carbon. **Carbonized meat may be unhealthy**.



There's another color you may notice in cooked meat: Pink. Many smoked meats turn bright pink just under the surface. Some people think that pink color means that meat is raw, but not in this case. If the meat were undercooked, the pink would be in the center, not just below the surface. Pink meat near the surface is a common phenomenon called the *smoke ring* and it is caused by gases in smoke preserving the color of myoglobin. Some people think the smoke ring improves taste. That's a myth too. **Click here to read more about the smoke ring and what causes it**.

WHAT HAPPENS WHEN YOU COOK?

Hot air cooks the surface of meat, but it cannot penetrate, so the energy built up on the outside of the meat moves slowly towards the center, eventually cooking the meat throughout. As the internal temp of your meat rises, its color is not the only thing that changes. A number of chemical and physical reactions take place, as the molecular structure of proteins

and fats are altered by heat. Different reactions kick in at different temperatures.

Here's a general guide to temperatures organized from cold to hot. The meat temps shown here are approximate because other variables come into play such as the age of the animal, acidity, salt content, type of heat, humidity, etc. This info has been gathered from multiple sources, including meat science research papers, textbooks, and **Harold McGee's important book, On Food And Cooking**. Click here for a **complete guide to target cooking temperatures**.

25°F (-4°C). Meat freezes. Meat starts to freeze at a lower temperature than water because water in meat is combined with proteins. Water expands as it freezes and sharp-edged crystals form that can rupture cell walls, creating "purge" when the meat is thawed, which is a spilling of liquid, mostly the pink fluid protein called myoglobin. Faster freezing makes smaller crystals, resulting in less purge.

34-39°F (1-4°C). Ideal refrigerator temperature. Water is not frozen, and microbial growth is minimized. You do have **a good refrigerator thermometer don't you**?

41-135°F (5-57°C). The "USDA Danger Zone," in which many pathogenic bacteria grow, sometimes doubling in number in as little as 20 minutes. According to the USDA, cold foods must be stored below 41°F (5°C), and hot foods above 135°F (57°C). **That's why we don't leave meats sitting around to come to room temp**.

60°F (15°C). When chilling cooked meat, liquid gelatin forms a solid gel called aspic. Gelatin happens when connective

tissues that wrap muscle fibers and connect them to bones, called collagen, melt. Yep, it's the same stuff they inject under your skin to hide wrinkles.

95-130°F (35-54°C). Animal fats start to soften and melt.

114°F (46°C). Myofibrillar proteins begin to gel, changing meat texture.

120°F (49°C). Myosin, a protein involved in muscle contraction within fibers, begins to lose its natural structure. It unwinds or unfolds, a process called denaturing. It starts to clump, gets milky, and begins firming up the muscle fibers. Purple meats, called "rare," start turning red. Fish begins to flake, and parasites begin to die.

130°F (54°C). Many pathogenic bacteria begin to die, slowly at first, but as the temp rises, they croak more rapidly. At this temp, it takes more than two hours to pasteurize meat. At 165°F (74°C), it takes just seconds.

130-135°F (54-57°C). Medium rare. Most mammal meats are at optimum tenderness, flavor, juiciness. If you eat your meat well-done, you need to snap out of it.

130-140°F (54-60°C). Fats begin to liquefy, a process called rendering. This is a slow process and can take hours if meat is held at this temp.

140°F (60°C). Connective tissues called collagens begin to contract and squeeze out pink juice from within muscle fibers into the spaces between the fibers and out to the surface. Meat begins to get dry. Myoglobin, the pink protein liquid within muscle cells, denatures rapidly and red or pink

juices begin to turn clear or tan and bead up on the surface. It is not blood!

150°F (66°C). Actin, another protein important to muscle contraction in live animals, begins to denature, making meat tougher and drier still.

150-165°F (66-74°C). This is "**the stall zone**," in which large cuts such as pork butt and beef brisket seem to get stuck for hours when cooked at low temperatures like 225°F (107°C). In this range, moisture evaporates and cools the meat like sweat on an athlete. Inexperienced cooks panic. Eventually, temps start rising again. Whew!

155°F (68°C). Known as "well done," meats are overcooked at this internal temperature. Much moisture has been squeezed out, and fibers have become tough. Bacteria are killed in less than 30 seconds, but spores can survive to much higher temps.

160-165°F (71-74°C). The "instant kill zone." Normal cooking temps kill microbes on the outside of meats rapidly, so solid muscle meats are not likely dangerous since contamination is almost always on the surface. But ground meats and poultry often have bad guys beyond the surface, so you must cook these meats beyond the instant kill zone. That's why the recommended internal temp for ground meats is 160°F (71°C) and for poultry is 165°F (74°C). When you reheat foods, you should take them up to 165°F 75°C).

160-205°F (71-96°C). Tough collagens melt and form luscious gelatin. The process can take hours, so low and slow cooking creates the most gelatin. Dehydrated muscle fibers

begin to fall apart and release from the bones. Meat becomes easy to shred. Even though the fibers have lost a lot of water, melted collagen and fat make the meat succulent.

212°F (100°C). Water boils at sea level. Boiling point declines about 2°F for every 1000′ above sea level.

225°F (107°C). Ideal air temperature for "low & slow" cooking of meats high in connective tissue. It is high enough so water evaporates from the surface to help form the desired crust called "**bark**," but low enough to get the most out of enzymes, collagen melting, and fat rendering.

310°F (154°C). The **Maillard reaction** accelerates surface browning, which is caused by chemical changes in proteins and sugars and results in thousands of delicious new molecules. The Maillard reaction begins at lower temps, but really takes off at 310°F (154°C).

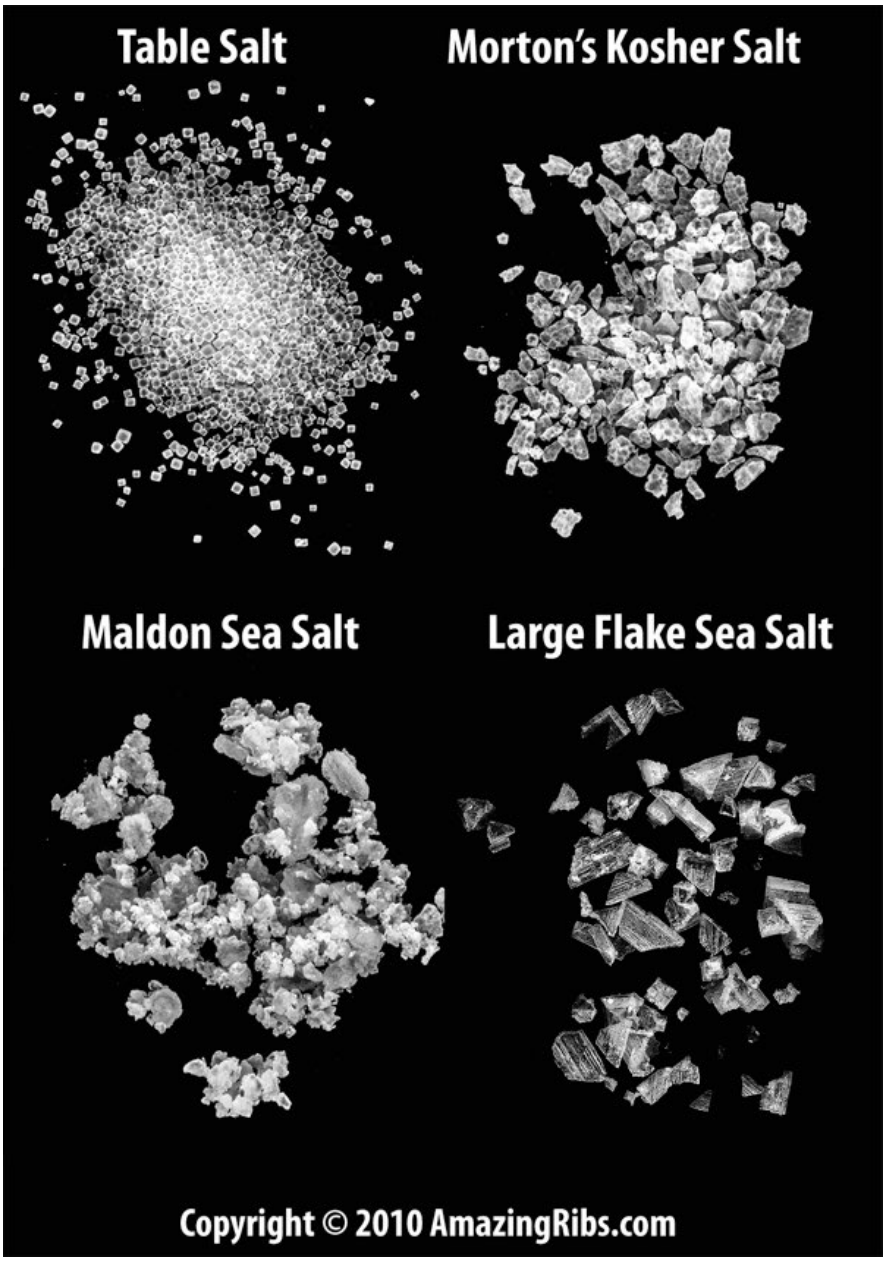
325°F (163°C). Ideal air temperature for cooking chicken and turkey so skin browns and fat renders.

361°F (183°C). Some animal fats begins to smoke.

570-750°F (299-399°C). Primary combustion temperature of hardwood, wherein it smolders and releases large quantities of unburned gases, including microscopic particles called smoke.

600-700°F (316-371°C). Flash point or fire point, the temperature at which smoke from burning fat can burst into flame. Never use water to extinguish burning fat. Smothering it works better.

SALT: THE MAGIC ROCK!



"One thing I like about Argentina, they only cook with salt. That's it."

— ROBERT DUVALL

If you like your meat juicy, tender, and flavorful, (and who doesn't?) salting, also called brining,

before you cook can improve it on all three fronts.

Salt does several things to the food. First of all, it amps up the taste because salt is a flavor enhancer. It does this without altering the flavor. Sugar, pepper, garlic, all the other spices and herbs change the flavor. But not salt. Salt turns the amp up to 11. And if you do it properly, it doesn't make the food taste salty.

First, it is important to know that all salt is not the same. The below quantities by volume have the same salinity because the grain sizes are different.

- **1 part Table Salt**
- **1 part Morton's Picking Salt**
- **1.3 parts Morton's Coarse Kosher Salt**
- **1.3 parts Windsor Kosher Salt**
- **2.1 parts Maldon Sea Salt**
- **2.3 parts Diamond Crystal Kosher Salt**

For more on the subject of how salt impacts food, read Meathead's article on The Science of Salt. It contains an interactive salt calculator and much more info about the different kinds of salt.

Something else happens because of salt. When meat cooks, a significant amount of water evaporates from the surface and some gets squeezed out from muscle fibers that contract when exposed to heat. This water is called drip loss or purge. Lean cuts like chicken breasts can dry out easily. How do you cook these cuts to safe temperatures without turning them

into shoe leather? Surprisingly, salt can help because it helps protein glom onto water.

Salt (NaCl) is made of sodium (Na) and chloride (Cl) ions that carry electrical charges. These ions attack the proteins, causing them to unwind a bit, a process called denaturing. These altered proteins have a greater ability to retain water, so meats that have been pre-salted remain moister throughout the cooking process.

Researchers at *Cooks Illustrated* discovered that a chicken soaked in plain water and another soaked in a brine, a mix of salt and water, each gained about 6% by weight. They cooked both birds, as well as an unsoaked bird straight from the packaging. Weighed after cooking, the unsoaked chicken lost 18% of its original weight, while the chicken soaked it water lost 12% of its original weight, and the brined chicken lost 7% of its weight. Thus, brining counteracts one of the biggest problems of grilling by helping hold moisture that is near the surface, which almost always dries out by the time the center is properly cooked.

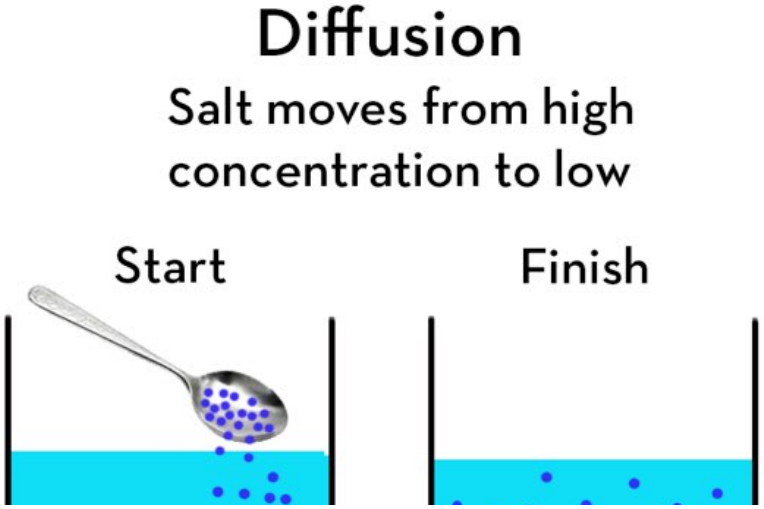
So salting before cooking, brining, has real benefits. And you need less than if you salt after cooking. And the amount of salt is small, not likely a risk to people on salt restricted diets.

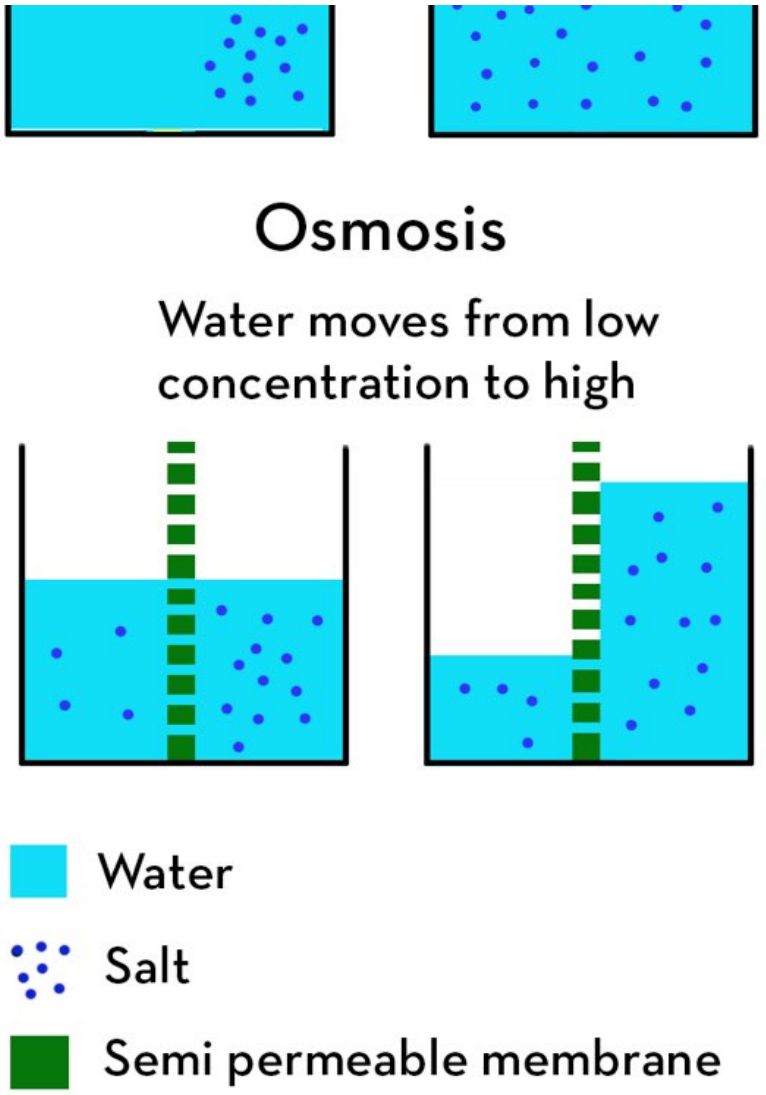
There are four ways to brine: Wet brine, dry brine, brinerade, and injection. Here they all are defined.

WET BRINE

This is the traditional method of salting meat, submerging it in a solution of 5 to 10% salinity (the ocean is about 3.5% salinity). To wet-brine, you need to calculate the amount of water and the amount of salt, and after that you have a potentially large container that must be fit into the fridge.

Cookbooks tell us that salt is pulled out of the brine and into the meat by osmosis. Not true. The process is actually called diffusion. Take a look at this illustration.





When salt is added to a solution, like a piece of chicken which is about 75% water, the salt diffuses or spreads out and seeks equilibrium. Osmosis is when the water moves into salty places through semi-permeable membranes in an attempt to achieve equilibrium.

The problem with wet brining poultry is that it can make the skin soggy and harder to crisp. That's why wet brining works best on boneless, skinless breasts—food that cooks so

quickly that the absorbed moisture doesn't have time to drip out. Chicken thighs, on the other hand, are moist enough from fat that they really don't need wet brines.

If you decide to wet brine, the brine should contain 5 to 10% salt by weight. Here's a simple formula. Add one cup of hot water to a two-cup measuring cup. Then pour in salt, any salt, until the water line reaches 1 ½ cups. That will be *about* 1/2 pound of salt by weight. Stir to dissolve then dump the solution into 1 gallon of cold water. This recipe results in a 6.4% brine regardless of the grain size of the salt.

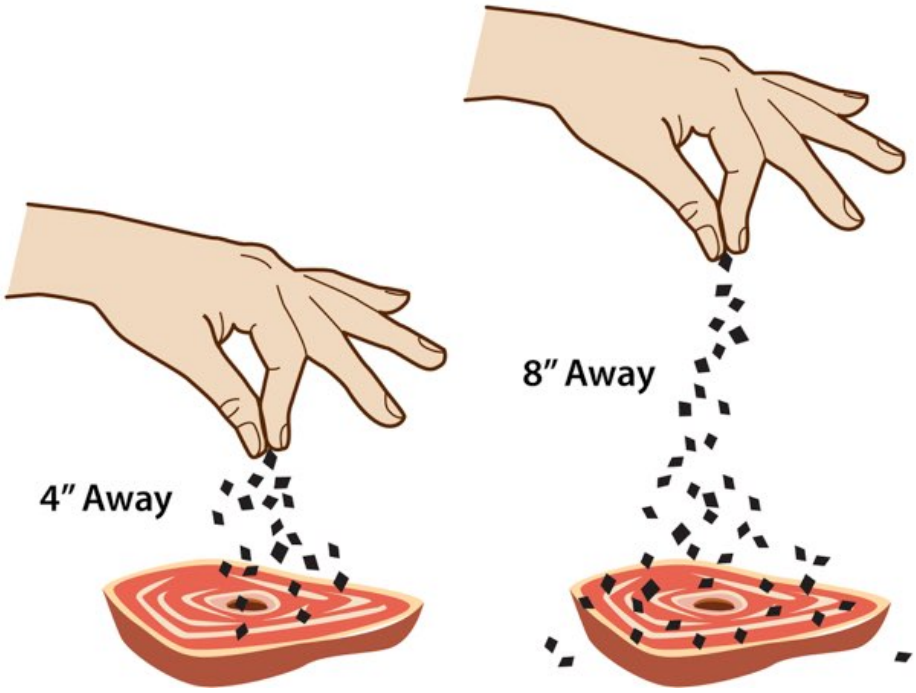
How do we know? Because a unit of salt by weight delivers the same salinity regardless of the grain size. A unit of salt by volume delivers different salinity because large grains have more air between them. In this recipe, the water infiltrates the voids between the grains of salt, compensating for the lower density.

Making brines is also easy with metric weight measurements, which are simple to scale up or down. Since 1 liter water = 1000 grams:

- **6% brine = 1 liter water with 60 grams any salt**
- **5% brine = 1 liter water with 50 grams any salt**
- **4% brine = 1 liter water with 40 grams any salt**

What's the right ratio of meat to brine? In general, soak 1 part meat in 2.5 parts brine. So for a 3 pound chicken (about 1.4 kg) use 3.5 kg of wet brine.

DRY BRINE



Dry brining is simpler and equally effective, plus it takes up less fridge space. Just skip the water. The late, great chef Judy Rodgers of Zuni Cafe. in San Francisco brought the technique of dry-brining into the mainstream, and since discovering her process, which Meathead named dry brining, we almost never wet brine anymore.

To dry brine, you simply salt the meat before cooking. How much salt? Salt tolerance is so personal that it's nearly impossible to give an exact amount.

A good rule of thumb is ½ teaspoon of Morton Coarse Kosher Salt per pound of trimmed meat.

Please note that the saltiness of different types of salt varies significantly due to the size and shape of the grains. Our standard is Morton kosher salt, but if you want to use table salt instead, use half as much. Click here to learn more about salt.

If dry-brining a whole bird or a roast, concentrate more salt on the thicker parts, like the breasts. Bonus: Dry-brining helps poultry skin crisp.

How long do you need to brine? Salt is a slow poke and creeps slowly through the thicket of muscle fibers. How long should the meat be in the brine? Here are some rules of thumb, not precise. Use them for wet or dry brining, and always brine in the refrigerator.

- **½ inch thick meat: about ½ hour**
- **1 inch thick meat: about 1 hour**
- **2 inch thick meat: about 4 hours**
- **3 inch thick meat: about 12 hours**

You want to salt your foods early. If you only have 30 minutes, fine. If you have 2 hours, that's even better. Got 24 hours? That's better still. The good news is that salt

continues to migrate throughout the meat during cooking and does so slightly faster due to the heat.

Leave the meat uncovered on a rack in a pan. This is especially important for poultry because we want the skin to dry out a bit. Just be careful that vegetables and other raw foods do not come in contact with raw meat. And don't rinse it off before cooking. After a few hours most of it has gone in and is well past the surface anyhow.

Whether it's for 30 minutes or 24 hours, pre-salting gives you a better tasting, juicier meat because salt penetrates and helps meat hold onto its juices. Just sprinkle a generous amount of salt all over, about 1/2 teaspoon Morton kosher salt per pound of meat. What about marinating? Forget it. Marinating steaks is a useless technique because marinades don't penetrate the meat much and you end up throwing away most of the flavor when you throw away the marinade.

With dry brining we simply sprinkle plain old salt on the meat a few hours before cooking. No more than you would use at the table.

Sounds simple, but something complex and wonderful happens. You can see it working in the pictures here. In the first picture above the meat has been sprinkled with Morton Coarse Kosher Salt. The salt draws water out of the meat. The water dissolves the salt. See how the meat has become shiny with moisture and the fat has become splotchy?

Then, in the next picture, the meat re-absorbs the moisture (and much of the juices that have leaked out) bringing the salt in with it. Notice how the color of the fat has changed where the salt has soaked in. Here's a slo-mo video of the process.

When it is time to cook there is no need to rinse off the salt. It should all be inside the meat.

Once inside the meat, it doesn't go far. As with wet brining, it stays near the surface, but that's where the moisture is needed because that's where we apply the most heat.

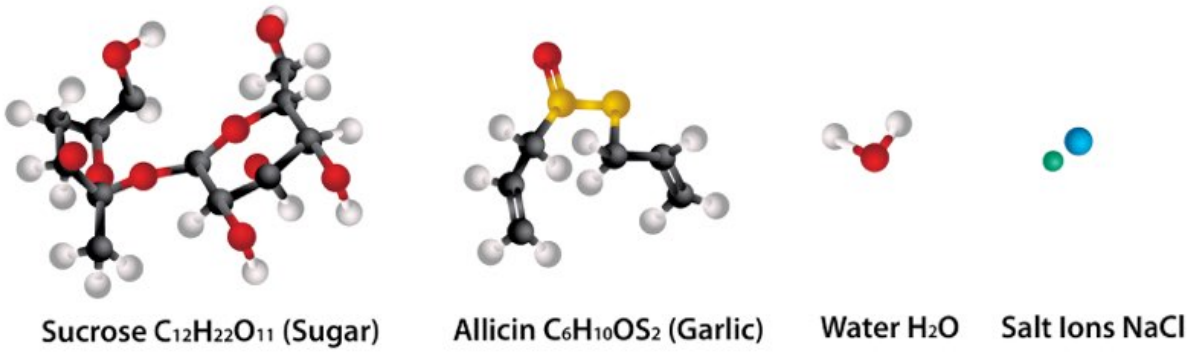
How does this work? The AmazingRibs.com Science Advisor, Prof. Greg Blonder, explains: "Salt is hygroscopic, which is a fancy way to say it absorbs moisture from the environment. Water is a 'V' shaped molecule. It has two positively charged hydrogen atoms on one tip of the V and one negatively charged oxygen on the other making H_2O. This asymmetry creates an electric field, kind of like a small magnet. The polar nature of water is why it's practically a universal solvent.

"When water in the air stumbles in very close to the NaCl crystal, the salt feels the attraction of the water's weak electric field, grabs it, and then breaks apart into a positively

charged sodium ion and a negatively charged chloride ion. When we sprinkle salt on a steak, water molecules, some from the air, but most from the meat, are captured on the surface of the salt crystal, and eventually, accumulate into a pool of briny liquid. Then, as the salty slurry diffuses into the meat, there is less salt on the surface to attract moisture, and the juices return to whence they came. Contrary to popular myth, there is no osmosis or cells breaking."

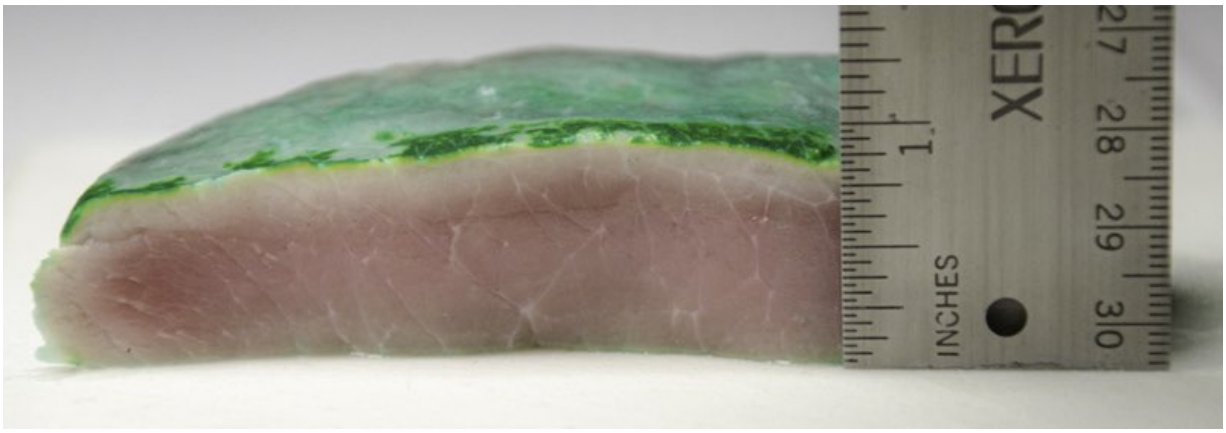
BRINERADES AND THE TRUTH ABOUT MARINADES

This fact always shocks people: Marinades rarely penetrate meat more than 1/8 inch. The molecules are just too large. Salt is only two atoms (NaCl), but sucrose (sugar) is 43 atoms ($C_{12}H_{22}O_{11}$). Likewise, garlic, onion, pepper, and all your other spices and herbs are all too large.



And for sure, oil in a marinade doesn't penetrate because meat is mostly water and oil and water don't mix. Here's a piece of chicken marinated for hours with a typical oil and vinegar marinade with some spices, herbs, salt, and some green food coloring to help us prove the point. As you can

see, there is no penetration (look at the bottom) except for salt, the slightly milky color about ¼ inch below the surface.



If you add salt to your marinade, it will find its way into the food. We call that a brinerade. How to make it? Prepare your marinade (skip the oil) and add the same amount of salt you would if you were making a wet brine.

- **6% brine = 1 liter water with 60 grams any salt**
- **5% brine = 1 liter water with 50 grams any salt**
- **4% brine = 1 liter water with 40 grams any salt**

So why marinate? Because marinades *can flavor the surface*, and if there is acid in the blend, it can tenderize the surface. And if there is salt it can brine. On the downside, a marinade can make poultry skin soggy and prevent it from crisping, and wet surfaces don't brown as well as dry ones. Remember: Brown is beautiful. Here's a way to improve marinades. Add salt to a marinade and it becomes a brinerade. The salt penetrates and helps retain moisture,

sugars help with browning, and everything else flavors the surface.

INJECTING

“I think everybody should have a great Wonderbra. There's so many ways to enhance.”

— CHRISTINA AGUILERA

ou don’t need a Wonderbra to enhance chicken and turkey breasts. Or, for that matter pork butt or beef pectorals. The

Y truth is that rubs, mops, marinating, brining, and sauces can deliver a lot of flavor to the *surface of meat*, but if you really want to get salt or flavor deep into meat, the solution is injecting.

Having an injector also opens up other fun possibilities: stuffing jam into donuts, syrup into ice-cream, and melted butter into squash.

Many meat processors routinely inject meats like turkey, chicken, and pork at the factory. Injecting, or enhancing as food processors call it, is a sure fire way to get the flavor and juiciness down deep. And it is the only way to get fats, herbs, spices and other large molecules deep into meat. You don't have to worry about oversalting, there's no waiting — you can do it at the last minute, you have less waste, no huge containers are needed, there are no refrigerator space problems, and there are few safety issues.

The secret to injecting is to go easy. A good guideline is to shoot for 1 to 2% salt. It is like brining and the salt helps retain moisture as well as enhances flavor. I skip the big flavors like garlic, pepper, and herbs that mask the natural flavor of the meat. I have judged pulled pork and brisket at barbecue competitions where the meat was gushing juice, but it didn't taste like meat. It tasted like apple juice and garlic. I want pork that tastes like pork, beef that tastes like beef, and turkey that tastes like turkey.

The best solutions are salt water, salted butter, or stock. And you don't need much. Muscle is 75% water and it is saturated. There isn't much room in there for more liquid.

Your injection will go in between the muscle fibers and bundles, not within the fibers, so you won't need much. Check out my recipes here.

Many competition cooks like to inject with a product called Fab B Light or Butcher BBQ Brisket Marinade, both moisturizers, tenderizers, and flavor enhancers. Fab B contains hydrolyzed soy protein, vegetable oil, sodium phosphates, monosodium glutamate, autolyzed yeast extract, xanthan gum, disodium inosinate, and guanylate. Butcher contains hydrolyzed vegetable protein (hydrolyzed soy and corn protein and salt, with partially hydrogenated vegetable oil [cottonseed, soybean] added), monosodium glutamate, sodium phosphate, and xanthan gum. Some traditionalists think this is way too Barry Bonds and are repulsed by the idea. The results speak for themselves. They are winning. A lot.

To inject, you need a gizmo, and something to put in it. Click here for our reviews of injection gizmos.

SEASONINGS AND RUBS

Meats are blank canvases to be painted with herbs, spices, and flavorful liquids. Rubs are simply spice blends that are sprinkled or rubbed onto meat before cooking. The rub should fuse onto the meat's surface and enhance the meat, but not overwhelm it.

It is helpful to think of salt as a treatment for the interior of a food, and herbs and spices, as a treatment for the exterior.

Every good barbecue cook should have a signature rub to brag about. In the recipe section of this book (below) there are a few rubs to get you started, then you can start riffing and invent your own. Once you find a rub recipe you like, make a batch and put it in a large spice shaker with a lid. If it clumps or cakes, take a tip from diner waitresses: Take some uncooked rice, place it in the oven at the lowest temperature to dry it out, and add it to the jar to absorb excess moisture.

Compared to salt, spices and herbs are huge molecules that just don't get more than a fraction of an inch past the surface. Think of salt as a treatment for the interior of the meat, and spices and herbs as an exterior treatment, like a sauce. The juices of the meat mix with the herbs and spices and they develop flavor during chemical reactions catalyzed by the heat of the fire. The form the flavorful crust.

Adding sugar to a rub or brinerade has some benefits. It aids in browning, especially at lower temperatures. Be aware:

Sugar burns easily, so you have to be really careful about temperature control and watch the cook very carefully. Also, if you smoke a wet brined meat that had sugar in the brine, it can get a slight hammy taste.

Beware: Some commercial rubs can be half salt. That's some expensive salt! But salt and spices should be applied differently. Because salt penetrates the meat, you need to apply it based on the weight of the meat. Because spices sit on the surface you apply them based on the surface area. For example: A slab of ribs and a hunk of pork shoulder might have the same amount of surface area but the shoulder can weigh 2 to 3 times the ribs and be many times thicker. So you need more salt on the shoulder but the same amount of spices. For this reason (and others) you should consider making your own rubs sans salt. We have rub recipes on AmazingRibs.com for pork, poultry, beef, lamb, seafood, and more. But if you don't want to bother, we have bottled rubs with salt for sale on our site. And yes, there is salt in them. Consumers expect rubs to contain salt and there just isn't room on the label to explain why it should be applied separately. Besides, if we left out the salt we would be priced out of the market.

Before sprinkling on the rub, many cooks like to coat the meat with a layer of mustard, ketchup, mayo, or water as a glue to hold onto the rub. These "slathers" have almost zero impact on flavor because they drip off and dry up during the cook. But they do work as a glue. Clint is partial to mayo because it is mostly oil and fat is flavor. Meathead just wets his hands and pats the meat to moisten it.

Don’t be stingy with the rub. With a spice shaker with large holes, sprinkle on enough to coat the surface but not so much that you can’t see the meat below. About 1 teaspoon for every 4 x 4-inch square is a good rule of thumb to start.

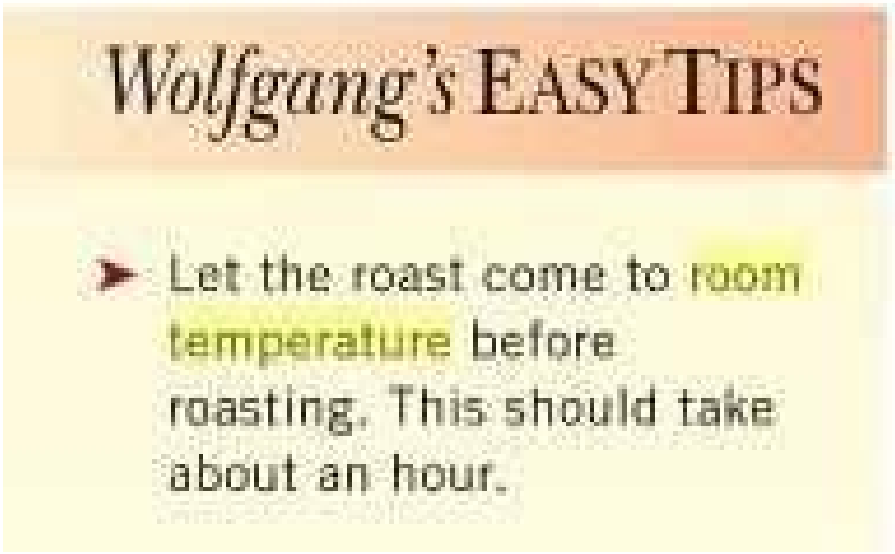
DON'T TRY TO BRING IT TO ROOM TEMPERATURE

A lot of recipes, including steak recipes, say that you should take the meat out of the fridge an hour or two before cooking and "let it come up to room temp."

Here's the theory: Say you want a steak to be served medium rare, about 130°F. If your fridge is 38°F, then the meat must climb 92°F. But if it is room temp, 72°F, then it needs to

climb only 58°F. It will cook faster and there will be less overcooked meat just below the surface.

Here's a picture of a page from a cookbook by Wolfgang Puck, a brilliant and famous TV chef with many restaurants. He says a big old roast should come to room temp in about an hour.



We tried it with a 3/4 inch steak and a really accurate thermocouple. It took just over an hour for the center to come to room temp. A 1 1/2 inch steak took just over two hours for the center to come to room temp. A 4 1/2 pound pork shoulder 3 1/2 inches thick took, are you ready for this, 10 hours! After two hours, the pork shoulder was only 49°F in the center, and after four hours it was only 56°F. Just a bit longer than Chef Puck thinks. Worse, after five hours it began to smell funny.

Why so long? Remember, meat is about 75% water, and most of it is trapped in cell fibers. This makes it a great insulator. So even though the center of a pork butt is only 1 3/4 inches from the surface, it takes 10 hours for the 72°F heat to penetrate. A mere 30 minutes in the oven at 225 to 325°F will warm the meat as much as an hour at a room temp of 72°F.

Now we know that, in theory, all contamination on whole muscle meats like steaks and roasts will be on the surface and not deep into the meat. We understand that within a minute on a hot grill all of the surface microbes will be dead. But we also know that the population can double in 20 minutes at room temp. So the idea of leaving a steak at room temp for more than 30 minutes or so gives us the creeps, especially if there are cracks and pits in which microbes can hide. Especially knowing that some processors use blade tenderizers, tiny knives that cut into the muscle to soften it, but in the process push surface contamination deep into the center. This is a practice that should be banned. Especially

since we will be cooking the steak to only 130°F, a temp that can kill microbes, but it can take hours to kill them all. But more important, over extended periods of time, putrefaction and rancidity set in, the meat starts to smell bad, and the entire flavor profile can change.

And it should go without saying, never leave poultry, burgers, or ground meat at room temp for more than a few minutes. They are susceptible to contamination within the meat and sitting around can really mess up these meats.

Think of letting cold meat sit at room temp as cooking it in a 72°F oven and then moving it to a hotter oven. It will take much longer than if you just put it in the hotter oven to begin with. But the reverse sear theory comes into play. Gentle heating helps ensure that the meat's internal temperature is more even from top to bottom than if it is exposed to high heat right away. But the microbial danger zone is in play as well. At 72°F, microbes are very happy and reproduce with abandon.

A steak cooked reverse sear. In the reverse sear process you are heating gently in a 225°F oven during the initial stage and then searing at very high "Warp 10" temperatures at the end. As we have shown, it can take two hours for a steak to get to room temp and in the oven/grill/pit it gets there in about 15 minutes. It is actually faster to go directly to the grill from the fridge.

A steak seared at Warp 10 first. You are clobbering the meat with a lot of heat and if you want to serve the meat at optimal medium rare, 130°F, you want the interior to remain

relatively cool so it doesn't overcook. Letting the meat come to room temp is actually self-defeating in this scenario. In fact, you are better off cooling it down in the freezer a few minutes.

Also, we now know thanks to the AmazingRibs.com science advisor, Prof. Greg Blonder, smoke sticks better to cold surfaces. So if you want a smokier tasting steak, take it straight from the fridge to the grill.

Here are three beer cans. The one on the right sat on a desk during Blonder's experiment. The one on the left was filled with ice water and placed in a smoker. The one in the middle was empty and placed in the smoker. You can see that the cold wet surface of the one on the left attracted more smoke and thus more flavor.

So in our homes, it's out of the fridge and onto the grill or oven.

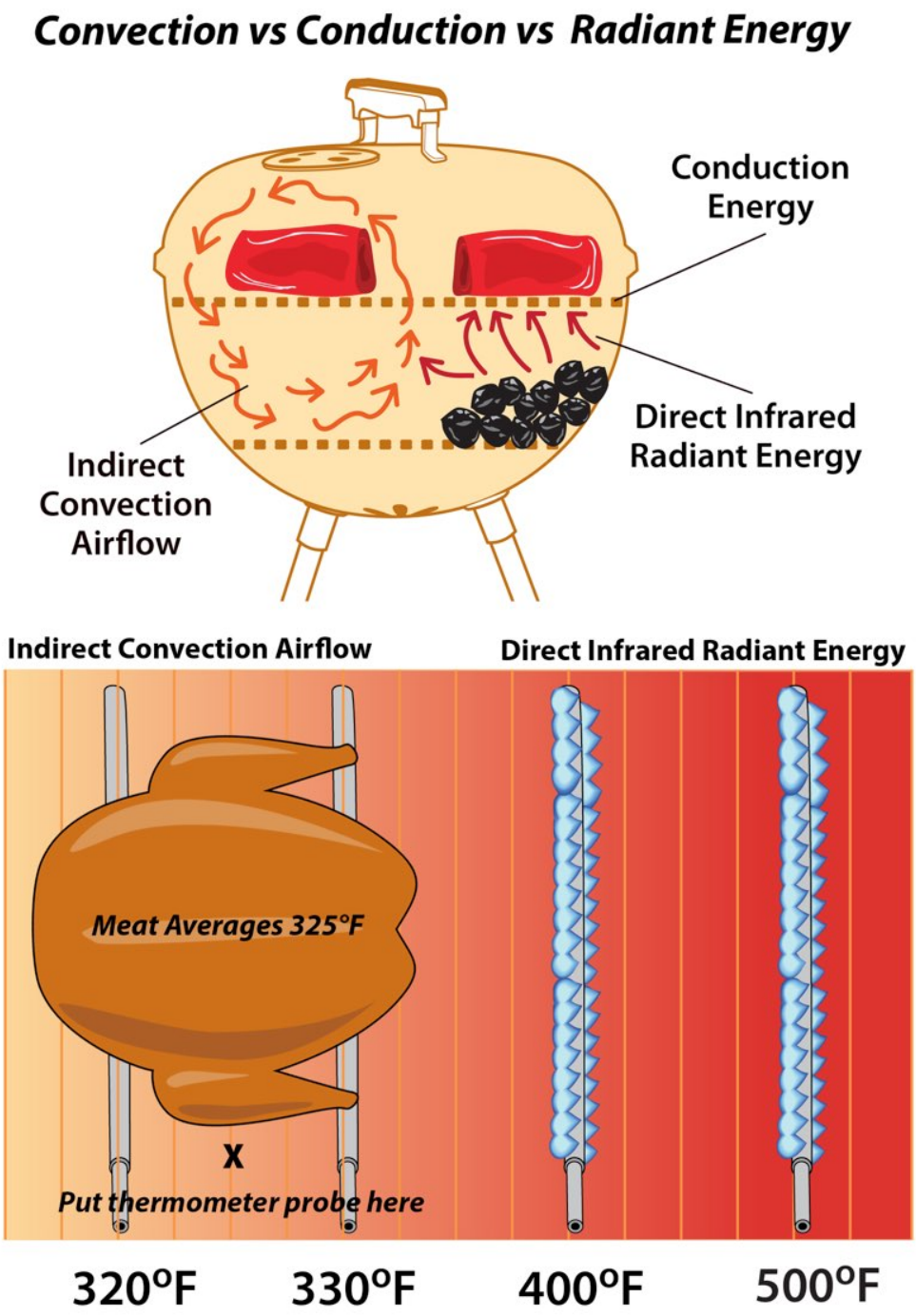
NO RESTING

Do not tent chicken with foil when it is finished cooking because the steam trapped under the foil softens the skin. Resting does not redistribute juices (that's a myth). And while it is resting, see all that steam? It is moisture that you want in the meat! Serve it hot and moist. Don't let it sit around cooling and drying out and overcooking via carryover.

3 TYPES OF ENERGY AND 2-ZONE COOKING

THE 3 TYPES OF ENERGY

Inside a grill there are three types of energy: Conduction, infrared radiation, and convection airflow. It is important to think of these as energy rather than temperature. As an example, turn your indoor oven to 200°F and stick your arm in there. You can do this. It won't burn your hair off. Now touch the metal grates. When you get back from the hospital you will understand that, although the air and the grates were both 200°F, they held and delivered vastly different levels of energy. That's why thermometers are important in measuring energy in a grill but they don't tell the whole story.



Conduction is the most concentrated energy and a basic example is food in contact with hot metal. Conduction from hot metal is what creates grill marks on the food.

Infrared radiation (IR) usually comes from flame or glowing embers directly below the food. This concentrated form of energy packs a wallop and helps sear foods and get dark crusts in a hurry. When you stand in the sun, you are getting bombarded by IR. Yes, there is ultraviolet (UV) that causes sunburn, but there is much less UV that IR. When you place food directly above hot coals or gas flames, you are subjecting it to IR. It is like putting it in the sun.

Both IR and conduction produce enough energy to sear foods. Searing is when food turns brown as a result of two a chemical reactions called the Maillard reaction and caramelization. That brown is flavor.

You can put a thermometer in a grill but it can be misleading because conduction and radiant energy are best measured in calories, not degrees of temperature. That's why we often refer to IR on as Warp 10 rather than measuring the air temp, a dumb Star Trek reference.

Convection airflow is the warm air circulating inside the grill, especially when the lid is down. Convection is not very good at searing. People often brag that their Big Green Avocado can hit 600°F or more, and although that is great for cooking food, it is not as good at browning it as conduction or radiation. Cooking with convection energy is best called roasting.

Once you understand these basics of energy transference you can use them to your advantage. And you thought you left physics behind in high school.

THE IMPORTANCE OF 2-ZONE COOKING

Cooking, indoors or out, is all about controlling energy and the way to do that is with 2-zone cooking. The concept is simple. You divide your grill in half. One side has IR from glowing coals or flame, the other side has no energy source beneath it and is warmed only by convection airflow. With this setup you can move food from gentle low energy that slowly warms the food and doesn't shrink the proteins and squeeze out juices, to rip snorting high energy that can sear the exterior.

For this reason we are not big fans of egg shaped kamados. Most of them are not easily set up in 2 zones.

PART V
TOOLS

You don't need a lot of fancy expensive tools to get started. You can accomplish wonders with a simple kettle grill or a two burner gas grill, a pair of tongs, a brush, and a digital thermometer.

That said, there are some great upgrades and enhancements that come in handy if you can afford them. Here are some of our recommendations.

At AmazingRibs.com we employ the world's only full-time grill and smoker tester and he maintains a database of detailed reviews and ratings of hundreds of cookers.

We also have an electrical engineer outfitted with special equipment to test and rate and review thermometers, the single most important tool for making safe and tasty food.

In addition, our experienced team tests and reviews everything from pizza ovens, to tongs, to spatulas, grill grates, knives, knife sharpeners, gloves, coolers, scales, pots and pans, kitchen equipment, all manner of accessories, and every year we pull together a list of the best new products and a great gift guide.

Click here to check out our Product Reviews section.

CHARCOAL GRILLS

Charcoal grills are the most versatile all-purpose outdoor cooker. When set up properly, the good ones can do both high energy infrared searing and low energy convection air roasting, as well as smoking. Their main advantages are that charcoal generates more energy than most gas burners and you can capture more smoke because the best charcoal grills allow you to control airflow. Gas grills have large permanently open vents so you can't easily contain the smoke, but they can do a respectable job. You just need to burn through a lot more wood.

Here is a picture of two slabs of ribs, one cooked on charcoal, one on gas. You can see the difference in color caused by the differences in the smoke.

To set up your grill for 2-zone cooking, simply pile lit charcoal briquets on one side of your grill's charcoal grate to create a hot (direct) infrared heat zone and a cool (indirect) convection airflow zone. You can also add a water/drip pan on the empty side of the charcoal grate and/or a second one directly above the charcoal on the main cooking grate if you wish. If you add water pan(s) you are adding moisture to the atmosphere, and if the water pan is above the heat source you are further protecting the meat from direct heat; the water absorbs heat, helping to keep the temperature down but does not steam the meat which will make it mushy. If you keep the oven temp at 225°F, the water should not boil because the surface area will allow evaporation that will cool the water keeping it below 212°F. Hard to believe, but true. If the water is boiling, you are running hot.

Intake dampers (on the bottom) are more effective at controlling the temperature than the exhaust dampers at the top of the grill because they reduce the supply of oxygen to the coals. So monkey with the intake dampers to control temperatures. Take your time getting the temperature right and try to maintain it throughout the cooking process.

Another reason for water pans is because water condenses on the relatively cool meat and keeps it cool, slowing the cook. Furthermore, smoke particles stick to the wet surface better than dry surfaces.

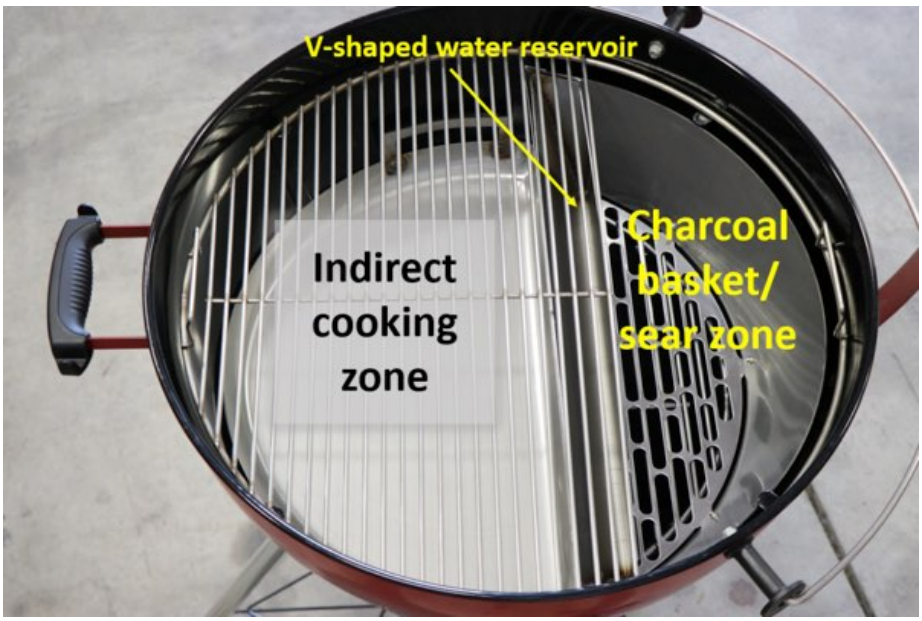
Cooking at 225°F will allow the meat to roast low and slow, liquefying the collagen in connective tissues and melting fats without getting the proteins knotted in a bunch. It's a magic temperature that creates silky texture, adds moisture, and

keeps the meat tender. If you can't hit 225°F, get as close as you can. Practice without food. Click here for more about how to calibrate your grill.

While lump charcoal is an option, we prefer briquets because they give us more control and we are control freaks (read our article on charcoal to see details). Absolutely do not use the instant igniting stuff that has solvent in it.

Chimney starters are by far the best way to start charcoal, especially for long slow cooking where the smell of the solvent in charcoal starter fluid can ruin the taste of the meat. Read how to start a charcoal fire here.

If you are using a charcoal grill or smoker, wait until the coals are white. The emit less smoke and the smoke from charcoal is not as good tasting as the smoke from wood. Then add about four ounces of dry hardwood or fruitwood to the fuel for at least the first hour of cooking. Do not overdo it on the wood as too much can result in a bitter and overpowering smoke flavor in the end product. If the result isn't smoky enough, add more the next time you cook.



If you are shopping for a grill that can also smoke, a great inexpensive solution is the good old fashioned Kettle. A stripped down model of the venerable Weber Kettle is still less than $200, and with the addition of a device called the Slow 'N Sear (above) for about another $100, you get a system that can both grill and smoke superbly, albeit with limited capacity. On one side it corrals all the coals behind a water reservoir; the food goes on the indirect side to smoke-roast at the perfect temperature. When you want to sizzle on the sauce (or sear a steak) you place it right above the glowing coals.

Another option are the Slow 'N Sear Kettle Grills. Similar to the Weber, it has several modernizations not the least of which, the two-zone insert is included. It has four legs, a thermometer port, and a side shelf.

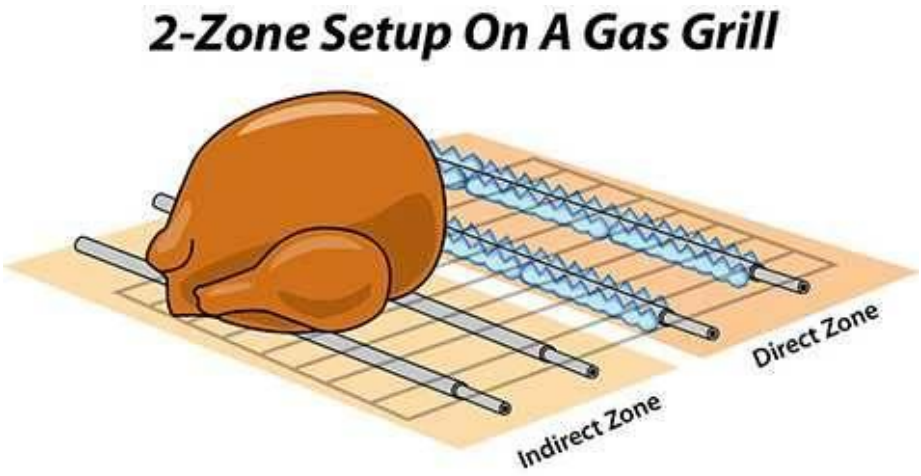
One of our favorite charcoal grills is the Portable Kitchen 360 (a.k.a. PK 360) for about $800 (above). Its rectangular shape makes it easy to set up in 2 zones and the coals are close to the cooking grate, making it superb for searing steaks.

Our all-time favorite is the Hasty Bake 357 (above) for about $3,600. It has all the bells and whistles and best of all, you can raise and lower the charcoal grate to control heat. Hasty Bake makes less expensive models you should consider if you fainted when you saw that number.

Click here to see our favorite charcoal grills.

GAS GRILLS

If you are using a gas grill you can easily create a 2-zone set-up and we think 2-zone is crucial for almost anything you are grilling. Most gas grills come with more than one burner nowadays because the concept of indirect cooking is becoming better known. When shopping for a gas grill, the more burners the better. Two is the minimum, three is better, four is best. You will appreciate the real estate and the ability to control temperature. Since law requires gas grills to have open vents, none of them allow you to control airflow, so there isn't a real significant difference between gas grills when it comes to smoking.

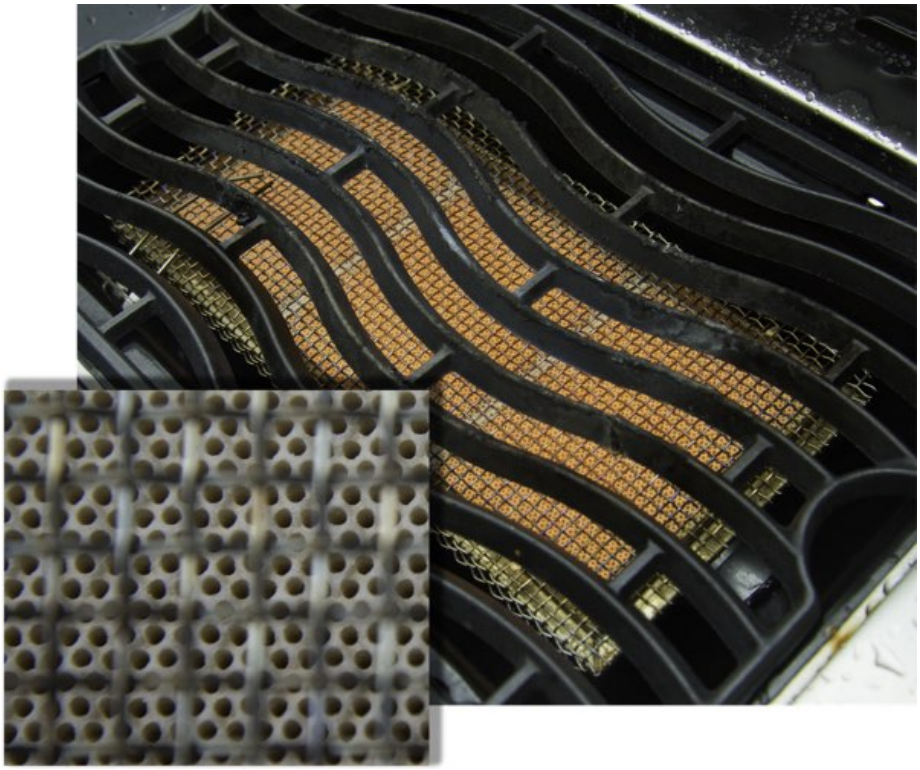


If you have a grill with only one burner, or if you have more meat than will fit in the indirect zone, try this technique. Put the wood as close to the flame as possible.

Regardless of how many burners you have, if you are going to smoke, put a pan of water between the burner and the food. The water absorbs heat and helps minimize fluctuations in temperature. The moisture also mixes with the smoke and propane combustion gases and creates flavors you cannot get with smoke alone. It also condenses on the meat cooling it and making a sticky surface for smoke to stick to.

The big difference among gas grills is their ability to sear at high temperatures. Unfortunately, most gassers just don’t generate enough IR to do a great job of searing. A few come with sear burner tubes, but even they are usually anemic.

The best sear burners are made of ceramic honeycombs like this one:



For a propane grill, make sure you always have a spare tank. Don't risk running out. Natural gas grills never run out because they are connected to the household gas supply.

Now that you have set up your grill for indirect cooking, throw some wood on the flames or the deflector right above the flames, place the meat as far from the heat source as possible, close the lid, and let the convection airflow, smoke, and seasoning do their jobs!

Click here for a look at our top rated gas grills.

SMOKERS

Steak likes a little smoke but not a lot. So usually we don't smoke them.

But if you want to, the best way to smoke is a dedicated smoker, but it is not hard to convince a charcoal or gas grill to do it very well, thank you. There are many different types of smokers ranging from about $200 to $20,000+. Selecting one is a whole 'nother book so let us refer you to some articles and videos on AmazingRibs.com, and our searchable database of hundreds of smokers tested by the world's only full-time grill and smoker tester, our very own Max Good. (We don't sell anything, but we do link you to places to buy.)

Most smokers cook food entirely with indirect convection airflow. The fire is away from the food. A few smokers use direct heat but the coals are kept at a distance.

There are many different types of smokers ranging from about $200 to $20,000+. Selecting one is a whole other book so let us refer you to some articles and videos on AmazingRibs.com, and our searchable database of hundreds of smokers tested by the world's only full-time grill and

smoker tester, our very own Max Good. (We don’t sell anything, but we do link you to places to buy.)

If you are just getting started and have a limited budget, we recommend the charcoal burning Pit Barrel Cooker (above) for about $350 delivered to your door fully assembled and ready to go.

The 18 inch Weber Smokey Mountain (above) is another great choice for about $330.

An excellent choice, but a bit more expensive, would be one of the many high-tech pellet smokers with precision digital temperature controls. They burn small pure sawdust pellets about the diameter of a pencil and function as thermostatically controlled outdoor ovens with smoke. Just set the temperature and walk away.

Small portable pellet smokers start at about $400, and full-size smokers about the size of a gas grill start at about $700. We gave high marks to the Grilla Silverbac Alpha (below).

Here's a list of all our top-rated pellet smoker models.

For the very best smoke flavor, we are partial to log burners. The good ones are not cheap. They start at about $800, so please don't be suckered into buying the cheap offset smokers at the big box hardware stores. Beware, log burners require constant tending and skill. Beginners will make mistakes and ruin a few meals. Below is a Lang reverse-flow offset smoker which is highly recommended. Click here to learn more about offset smokers.

The odd looking thing below is a Karubecue. It employs a number of brilliant innovations that make it the best

backyard log burner on the market. It costs about $1,440 at press time.

There are gas smokers and we like them because you can set em and forget em. They don't require the vigilance that charcoal and log burners demand. And they are inexpensive. Alas, some make temp control difficult, so be sure to check our reviews before buying.

There are electric smokers, but the wood smolders and does not burn in them. Burning wood produces better tasting smoke than smoldering wood so for that reason we are not fans of electric smokers.

Looking for a new outdoor cooking rig? Here's a web page with a lot of info, videos, and links on how to select a grill or smoker.

ABOUT WOOD

Then there is smoke, which we think of as a spice or flavoring element. Some of it comes from charcoal (gas has no flavor), some of it comes from vaporized drippings of juices, fat, and spices. But the best smoke flavor comes from burning wood.

Charcoal is not a very good source of smoke. When you first light charcoal it produces an acrid smoke. When it is fully ignited and has a thin coat of white ash, charcoal produces very little smoke. That is when you add real wood.

The best smoker is a dedicated smoker, but it is not hard to convince a charcoal or gas grill to do it very well, thank you. All you need to do is use a 2-zone set-up and throw hardwood, fruitwood, or nutwood on the flames and let it burn. That's right, let it catch fire and burn. You won't see a lot of smoke, but that's what you want. The truth is that billowing white smoke from smoldering wood does not taste as good as "blue smoke," smoke whose particles are so small they don't diffract much light, so the smoke is thin, pale blue, and practically invisible. Those flames you see are combusting impurities that impart undesirable flavors. So let it burn!

Never use any kind of pine or sappy, soft wood unless you want meat that tastes like turpentine. Never use construction lumber because it is often treated with poisonous chemicals to discourage rot and termites.

Charcoal is not a good source of smoke. When you first light charcoal it produces an acrid smoke. When it is fully ignited and has a thin coat of white ash charcoal and produces little smoke. That is when you add real wood.

We don't care what you have read, there is no need to soak wood before adding it. First of all, wood doesn't absorb much water. That's why they build boats from wood! We have soaked wood and cut it open and the interior is bone dry.

There is only a little moisture captured on the surface. When we weigh wood soaked overnight it gains less than 5% of its original weight.

Secondly, all that billowy white smoke from smoked wood is really steam because the wood cannot combust until the water on the surface of the wood evaporates at 212°F. Then the wood can go up in temperature to 500°F+ where it can combust. At that point, it burns with a bright blue and orange flame, making clean blue smoke with few impurities.

Don’t obsess over which wood to use . The differences are subtle and you should concentrate first on getting quality meat, trimming it, salting it, rubbing it, temperature control, and sauce management. Wood theory is a book length topic unto itself, so if you want to know more and learn why we tell you not to obsess over wood types, click here to learn about combustion and the different kinds of wood and smoke.

Do not overdo it on the wood as too much can result in an overpowering ash flavor in your food. Go easy the first few cooks and add more as you gain experience.

On charcoal or gas cookers, start with 4 to 8 ounces by weight of chunks, chips, or pellets for a mild smoke flavor that complements the meat and seasoning without overwhelming. No matter how much food you are cooking, 8 ounces should be enough. You don't have to be precise, just measure it in some fashion so you have a baseline for your next cook. Then you can add or subtract if you wish.

THE ABCS OF FIRE EXTINGUISHERS

Always keep a fire extinguisher near your grill, smoker, and in your kitchen. Water will only spread grease fires. The best extinguisher is rated ABC.

- **Class A** fire extinguishers are for paper, wood, cardboard, and most plastics.
- **Class B** fire extinguishers are for flammable liquids such as gasoline, kerosene, oil, and grease.
- **Class C** fire extinguishers are for electrical equipment and wiring.
- **Class D** fire extinguishers are for combustible metals including magnesium, titanium, potassium, sodium, and some other chemicals.
- **Class ABC** fire extinguishers can handle most everything except some class D materials. This is the one you want. Beware, they contain a yellow powder that can damage electrical devices.

COOK WITH A THERMOMETER, NOT A CLOCK

COOK WITH A THERMOMETER, NOT A CLOCK

Different cuts of meat vary significantly in tenderness, fat content, and collagen content. Some are best cooked hot and fast, some better cooked low and slow, and some must be cooked with a combination of hot and slow to reach their optimal taste and texture. Click here to read an article on the subject of cooking temps and info on how to get this food temperature guide with more than 80 benchmark temperatures.

This is why cooking times in recipes are guesstimates at best. Think about the absurdity of a recipe that says, "cook the steak for six minutes on the first side and then four minutes on the second side." How long it takes to cook depends on how hot the air is, how hot the cooking surface is, how thick the meat is, and your target temp.

Depending on the grill, cooking steaks could take twice as long or half as long. Thick steaks take more time, and if you want them rare, they'll take less time than in if you want them well done. Click here for more on cooking times and what controls them.

You cannot tell if meat is safe or cooked to the proper temp by looking at it. When you cut into meat to look at it, it can change in a few minutes after it has been exposed to oxygen. Compounds in marinades and brines can impact color. Sometimes vegetables in the grill can produce gases that alter meat color. It has long been thought that when chicken juices run clear the meat is safe, but modern chicken farming has changed that. Click here to read how we bust the myth of clear chicken juices.

The truth is, meat can go from succulent to sucky in just a few minutes. The only way to be sure about doneness is to use a digital thermometer. Overcook meat and you've wasted your money. Undercook it, and you could give someone a tummy ache or much worse. That is why you ALWAYS cook with a thermometer, not a clock. This is the 21st century. The digital age. Stop using 19th century technology. Ditch your dial telephone and your dial thermometer.


DIGITAL THERMOMETER
ON
OFF
224.9
50F Low


ThermoWorks
OL
259.8
100F Low


50F Low


60F High
BRINKMANN
237
REMOTE RECEIVER


45F Low
BEEF
235
344


236
REMOTE RECEIVER
BBQ
56F Low


226
REMOTE RECEIVER
BBQ
25F Low


ThermoWorks
602
TEL-TRU
40F High

And while you are at it, get a digital oven thermometer. The cheap dial thermometer that came on your grill or smoker is probably off by 25 to 50°F like the one above. I have seen them off by 100°F!

Click this link for a buying guide to thermometers with more than 150 test results from our on-staff electrical engineer.

As the internal temp of meat climbs, more water gets squeezed out, and the meat becomes drier. In general, most meats are juiciest when cooked to medium rare, 130 to 135°F internal temperature.

But that's not hot enough for safety in some meats. Ground meats and poultry are health risks at those temps. Ground meats need to be cooked to 160°F, and poultry needs to go to 165°F to kill pathogenic bacteria. But there's more to the story than that. You can actually serve these meats at lower temps if you know the rules. **Read my article on meat temperatures**.

Meats with a lot of connective tissue such as beef and pork ribs, pork shoulder, and beef brisket, are too tough at these lower temps. They need to go up to 200 to 205°F in order to gelatinize collagens and melt fats. That's well past well done, and yes, water is lost, but the gelatin and melted fats lube the meat and make it taste tender and juicy.

Be aware that if you let meat sit around after you remove it from the heat, the heat built up in the outer layers will push down to the center and overcook the meat, a process called **carryover cooking**. The good news is that **resting meat**

is probably not necessary, despite what all the TV chefs say. For more about ideal serving temps, **read my detailed Food Temperature Guide**, which has a handy printout for your fridge.

A good digital thermometer is the most important tool you can own. As for monitoring and maintaining the desired grill/smoker temperature, the built-in thermometers are generally worthless. They are called bi-metal thermometers and most are slow and inaccurate. To become master of your instrument, you need a good *digital* oven thermometer to measure the air temp.

You also want a thermometer that can measure food temperature in 5 seconds or less. Here is the Thermoworks Dot for about $40, the best all-purpose thermometer going for the price. It can be clipped to the cooking grates to measure oven air temperature, inserted into meat to provide constant readings throughout a long cook, or inserted in meat for rapid spot readings. For other options, go to AmazingRibs.com and click on Ratings & Reviews and then thermometers. We have an electrical engineer equipped with

special equipment to measure accuracy and speed. He has tested and reviewed hundreds.

They range from $20 to $200 and can have as many a six probes. Several have two monitors, one attached to a probe on a cable like the Dot And the other that it talks to with wireless tech so you can carry a monitor in your pocket while you cut the lawn or watch the game. There are even thermostats that can control the temperature of your charcoal grill.

SOUS VIDE QUE

The ultimate solution to preventing dry meat is cooking with a technique called *sous vide* and then finishing it on the grill. We call this *sous vide que* and we discuss this marvelous method, with videos on this page on our website. For a Deep Dive on the subject, we have written an ebook called "Sous Vide Que Made Easy: How To Deliciously Marry The Grill And Smoker With Sous Vide" .

When cooking sous vide you first salt the meat then put it in a plastic bag, squeeze the air out of the bag, and submerge it in water that is heated with an “immersion circulator.” It can hold the temperature precisely and consistently at, let’s say, 131°F for red meats and 154°F for poultry. You wait for the center of the meat to reach the target temp, and hold it there long enough to make it tender and pasteurized, about two hours. It is impossible to overcook this way.

The problem with sous vide is that, although the meat comes out tender and juicy, red meat surface is ugly grey and poultry the skin is flabby and bland. That's where the "Que" comes in. You finish it by adding the rub and placing the meat over a hot grill for a few minutes to create the Maillard reaction crust and flavors of browning. Another option after the sous vide step is to put the meat in a smoker at 225-325°F for 30 minutes. The results are extremely tender and tasty.

ADDITIONAL TOOLS

In addition to the smoker/grill and fuel, there are a few other tools that you will want to have on hand before you start cooking, including:

TONGS

These 12-inch tongs from OXO make it simple to move chicken parts around your grill. They also lock closed for easy storage.

A SILICONE SAUCE BRUSH

When it comes to saucing, bristle brushes are really hard to clean and can harbor pathogenic bacteria. Throw them out and get a good silicone sauce brush. They are easy to clean, they're dishwasher safe, and they load up with a lot of sauce.

A GOOD CUTTING BOARD

We are partial to plastic cutting boards because they can be cleaned in the dishwasher and if they get gouged you can sand them smooth. This double sided one from OXO has grips so it doesn't slide around on the counter and gutters along the edges to capture juices. It is under $20.

A FILLET KNIFE

These cheapo filleting knives from Rapala are beloved by fishermen. They have thin flexible blades with a dangerously sharp edge and a wicked sharp tip and soft handle. The 9-inch model costs less than $30. It's great for separating ribs, slicing tomatoes, removing silverskin/membrane on meat, boning, slicing the ribs and seeds out of hot peppers, and, of course, filleting. It is not strong enough for cutting through bone, but there is nothing better for cutting meat *off* the bone. When it is dirty, it goes in the dishwasher. When it's

dull, we sharpen it. When we can't get it as sharp as new, we get a new one.

A RIB HOLDER

If you are hosting Fourth of July and have a crowd coming and limited grill space, a wire rib holder like this one for less than $20 can handle five slabs. Just beware, because the slabs are close together airflow and smoke-flow are hampered, so cooking time can be significantly longer.

18-INCH WIDE HEAVY DUTY ALUMINUM FOIL

Essential if you opt for the Texas crutch. We prefer it to butcher paper because it is easier to get a good seal.

A LOUNGE CHAIR

Once you settle into a La Fuma lounge chair or one of its imitators, you will not want to get up.

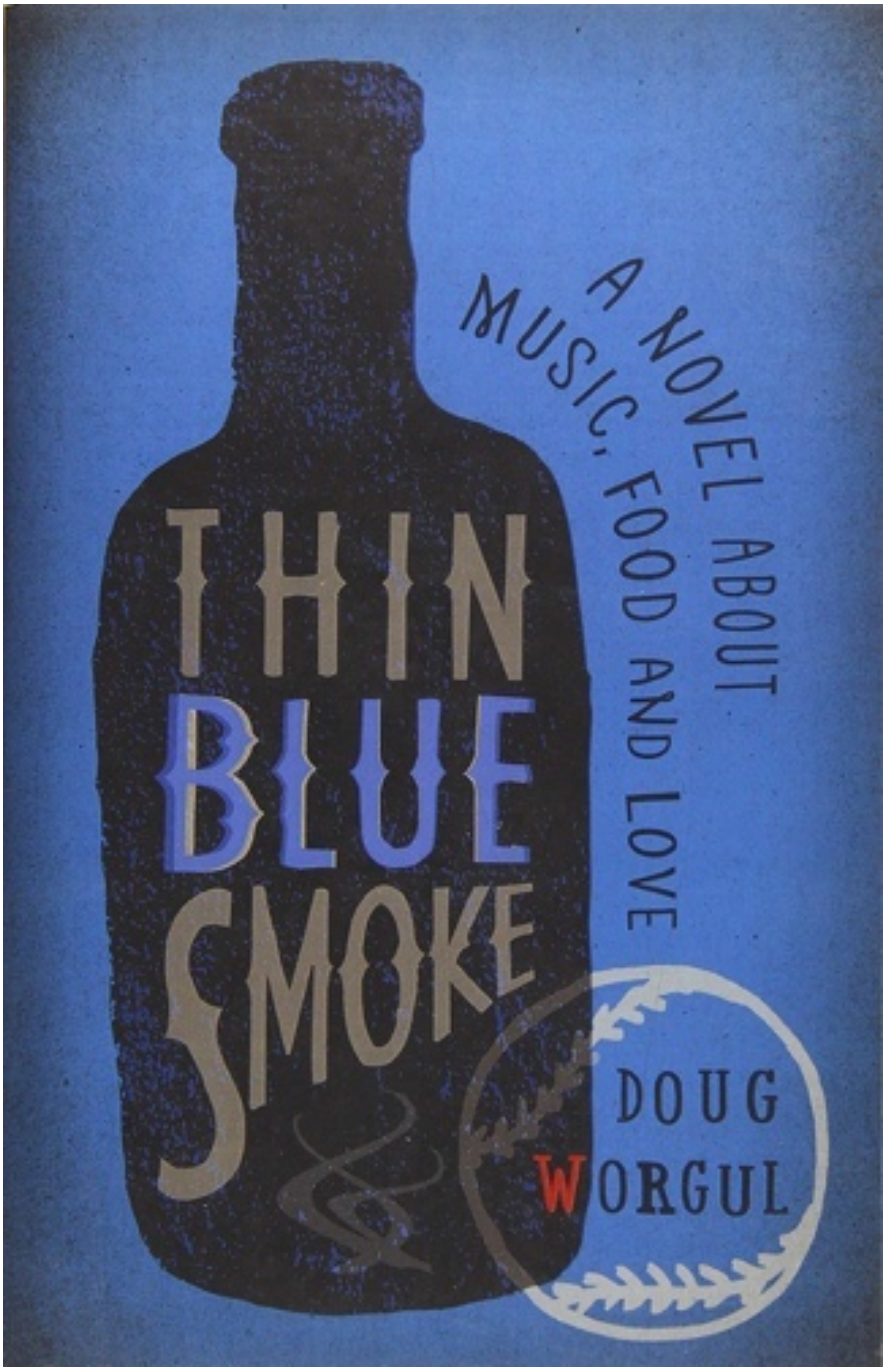
A SIX-PACK OF BEER

For the cook, not the meat.

A GOOD BOOK

A darn good read, *Thin Blue Smoke: A Novel About Music, Food, And Love* by Doug Worgul is well worth your attention. And not just because it has barbecue at its core. *Thin Blue Smoke* comes to life with some fascinating characters whose stories intersect with those of the main character, LaVerne Williams, a former major league baseball player who has an attitude, a rap sheet, and a Kansas City barbecue joint called "Smoke Meat." The writer, Doug Worgul, has a day job as marketing director for one of the nation's best barbecue joints, Joe's Kansas City Bar-B-Que in KC, so this storyteller knows the turf. In Worgul's hands, the travails of a small-

time black restaurateur in the barbecue capital of the world ring true. Of course, Worgul's tale also weaves in music, whiskey, religion, profanity, love, lies, and laughter.



TUNES

Start with the great Louis Armstrong's "Struttin With Some Barbecue" (it's not really about barbecue, click here to read the backstory). To get you in the groove, we have a playlist of our favorite food tunes.

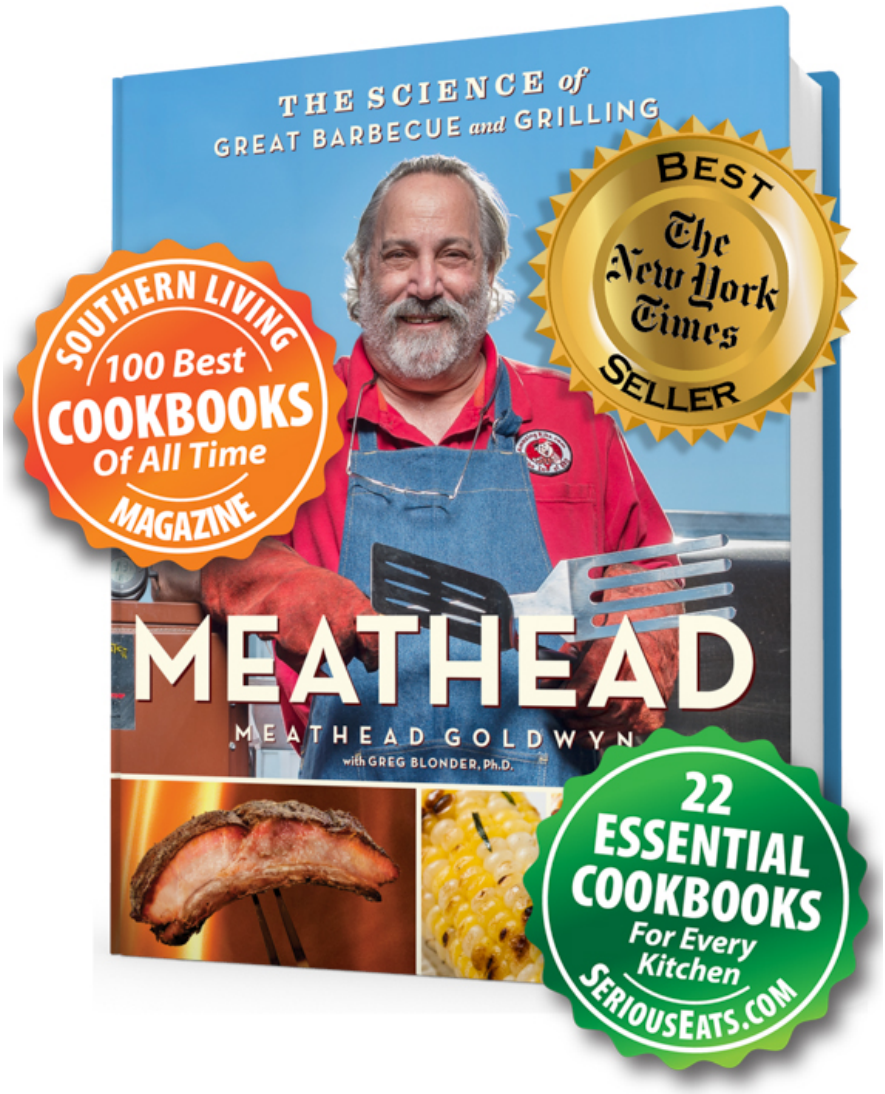
PART VI
THE MEATHEAD METHOD

“Always remember, cooking for others is an act of love, and the most important part of the meal is not what's on the plate, but who's in the chairs.”

— *MEATHEAD*

Just what the heck is the Meathead Method?

It is the melding of science and art to create deliciousness and to nourish the soul as well as the body. It is a suite of science-based techniques that form the toolbox with which you can elevate your cooking, and hopefully gain creative inspiration.



I am honored that my hardbound book, ***Meathead, The Science Of Great Barbecue And Grilling***, made a lot of best cookbook lists including "The 100 Best Cookbooks of All Time" by Southern Living and that many cooks now employ my concepts. The reason for the accolades is simple, for years I have been questioning conventional wisdom and testing what I call "Old Husbands' Tales." When the lessons I have learned are woven together they comprise a comprehensive philosophy and approach to culinary arts

that have form The Meathead Method. I believe the Meathead Method can change your life like it changed mine.

I have written about the Meathead Method on Meathead's AmazingRibs.com, but the web is not the best learning environment. A morsel of info here, click, jump, a snack there, click, jump a crumb next. A book, or in this case, two books, with a beginning, middle, and end is a far better way to get the big picture.

I am currently writing my next hardbound book not surprisingly named ***The Meathead Method, Barbecue Science Meets Culinary Art.*** I am very pleased with its progress. Be sure to subscribe to my email newsletter to hear about it when it is published.

SOUS VIDE IS JUST ANOTHER WAY TO GO LOW AND SLOW

Sous vide is a concept that barbecue fans know well: Low and slow cooking. There are numerous advantages to low and slow. At high temperatures meat proteins shrink and squeeze out water, making the meat tough and dry. Cooking at low temperatures takes longer but the reward is great.

With most conventional cooking, whether in an oven, in a pan, under a broiler, or even in a slow cooker, the temperature of the air is much hotter than the target temperature of the food. Getting food cooked properly is like jumping off an express train that won't stop at the station. You have a very narrow window of time to jump, and it is easy to miss the station and overcook or undercook.

If you are grilling a steak, for example, the target for best flavor, juiciness, and texture is medium rare, 130 to 135°F in the center. Typically, your grill’s air temperature is around 400°F and the meat is often right over intense infrared radiant energy (IR). As the steak cooks, the exterior browns and the interior temperature of the steak rises unevenly

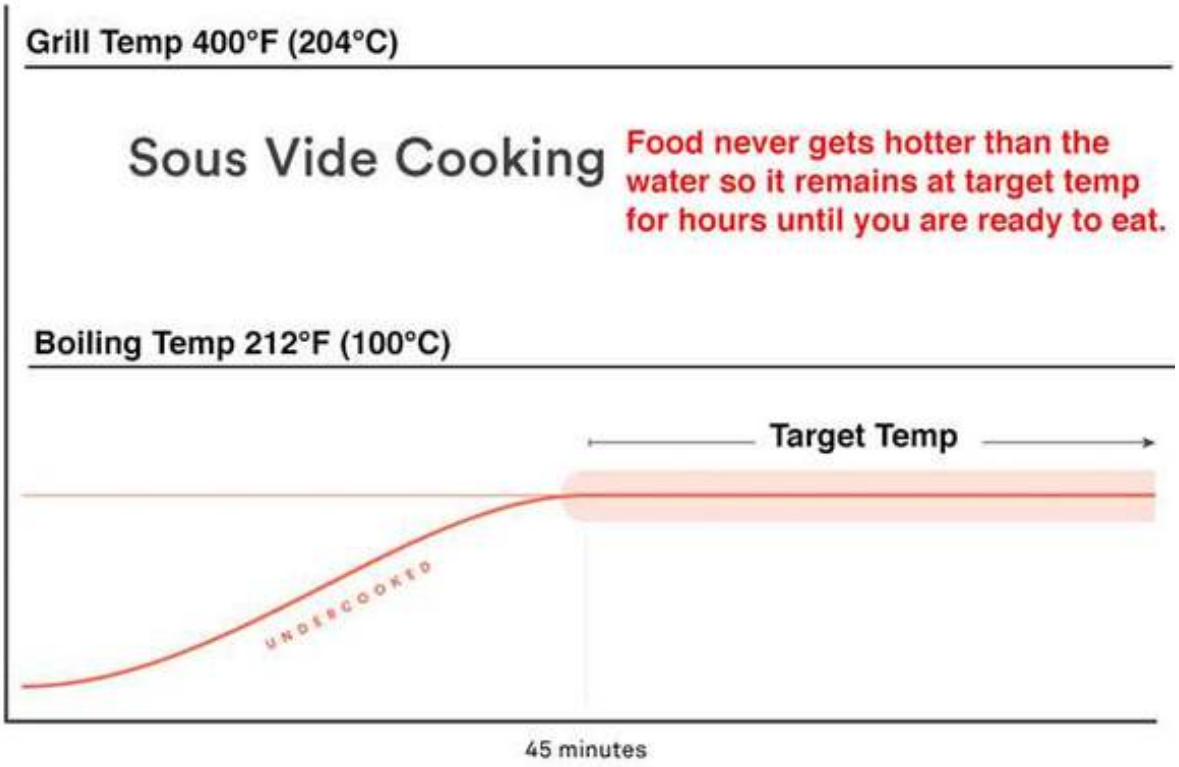
while heat builds in the outer layer and slowly marches to the center. You have to monitor the interior and exterior carefully because, if you leave it alone, it can easily overcook on the inside or burn on the outside. Then you've wasted good money and you have to apologize to your guests.

With traditional grilling or cooking in an oven or pan, the core temperature of the food cannot go past boiling temperature until the water evaporates. So it starts rising and keeps rising until it hits 212°F regardless of the temperature around it. But if you are not armed with a good thermometer and if you drop your guard, it will zoom right past your target temperature like that express train.

When cooking sous vide you are no longer on the express train preparing to jump, you are sitting in a chauffeured limo

and the driver stops exactly where you want, anywhere you want, and stays there until you are good and ready to get off. You set the finished temperature, let's say 131°F, and the food goes to that number and never above or below. You cannot over or undercook.

Here's another short video that explains the entire sous vide que process.



ADDED BENEFITS

It takes time to melt tough connective tissue, to render fat, and for enzymes to kick in and tenderize. With sous vide you can hold the food at the target temperature for hours, giving enzymes the time they need to do their thing and time to produce extremely juicy and tender food.

Another great benefit to sous vide is that it can save money. It can make tough cuts of meat as tender as expensive ones. Cuts from the hardworking hip area such as rump roast and eye of round can come out as tender as cuts from the pricey back such as ribeye and strip. The process is also good at breaking down woodiness in vegetables.

Because food is cooked in a sealed bag, juices envelop the meat with liquid doing something like braising although, technically, it is not braising because that is usually done at a low simmer, in the 180 to 190°F range, much warmer than any meat you cook sous vide. Braising is famous for producing tender meat, and sous vide is better than braising.

Juices that remain in the bag may be used to make a sauce. We will discuss this below.

Another great advantage to sous vide is that once the food is cooked long enough it is pasteurized and it can be stored in the fridge for days or in the freezer for months. If the bag is sealed tight the food remains free from bacterial harm. It can then be warmed and served whenever you need it.

THE BEST THINGS TO COOK

You can cook just about anything, but sous vide excels at tough or dry cuts from hardworking muscles such as:

- Ribs, shoulders, rumps, legs, briskets, flank, and tongue.
- Pork loin chops.
- Poultry breasts and legs.
- Game.
- Vegetables, especially carrots and other root veggies.
- Dried legumes and beans.
- Advanced pie makers will cook apple peels and cores or pineapple cores sous vide to extract the juices, which are then used in their fillings.
- Infusions in alcohol.

Yes, you can cook fish and beef tenderloin, but the gain is minor. They are going to be tender and juicy if you cook them conventionally, as long as you mind your temps. But if

you are careless about cooking temps and don’t pay attention, then cook everything sous vide!

WHAT YOU DO

Here is a quick summary of the steps for a basic sous vide que (SVQ) recipe in order. Details follow.

1. Trim the food.
2. Dry brine it.
3. Bag it.
4. Sous vide cook.
5. Optional: Chill.
6. Season with spices and/or herbs.
7. Smoke and/or sear.
8. Sauce (optional).
9. Serve.

TRIM

The first step is to trim excess fat. Meat is 70% water and **surface fat cannot penetrate it**. Most diners will trim off fat at the table. Marbling, however is fat between muscle fibers and is essential to flavor.

DON'T WASH YOUR MEAT

Rinsing meat can remove slimy fluids on the surface, but these are really nothing much to worry about. To be sure there are bacteria in them, but they will be killed instantly when heated. Rinsing is helpful to remove bone chips that might be on the surface from the butchering process because many cuts through bone are made with band saws.

Unfortunately, rinsing meat in the sink cannot remove bacteria which are embedded in the pores and cracks in the muscle surfaces. In fact, rinsing can make things worse by splattering microscopic contaminated droplets onto the sink and counters.

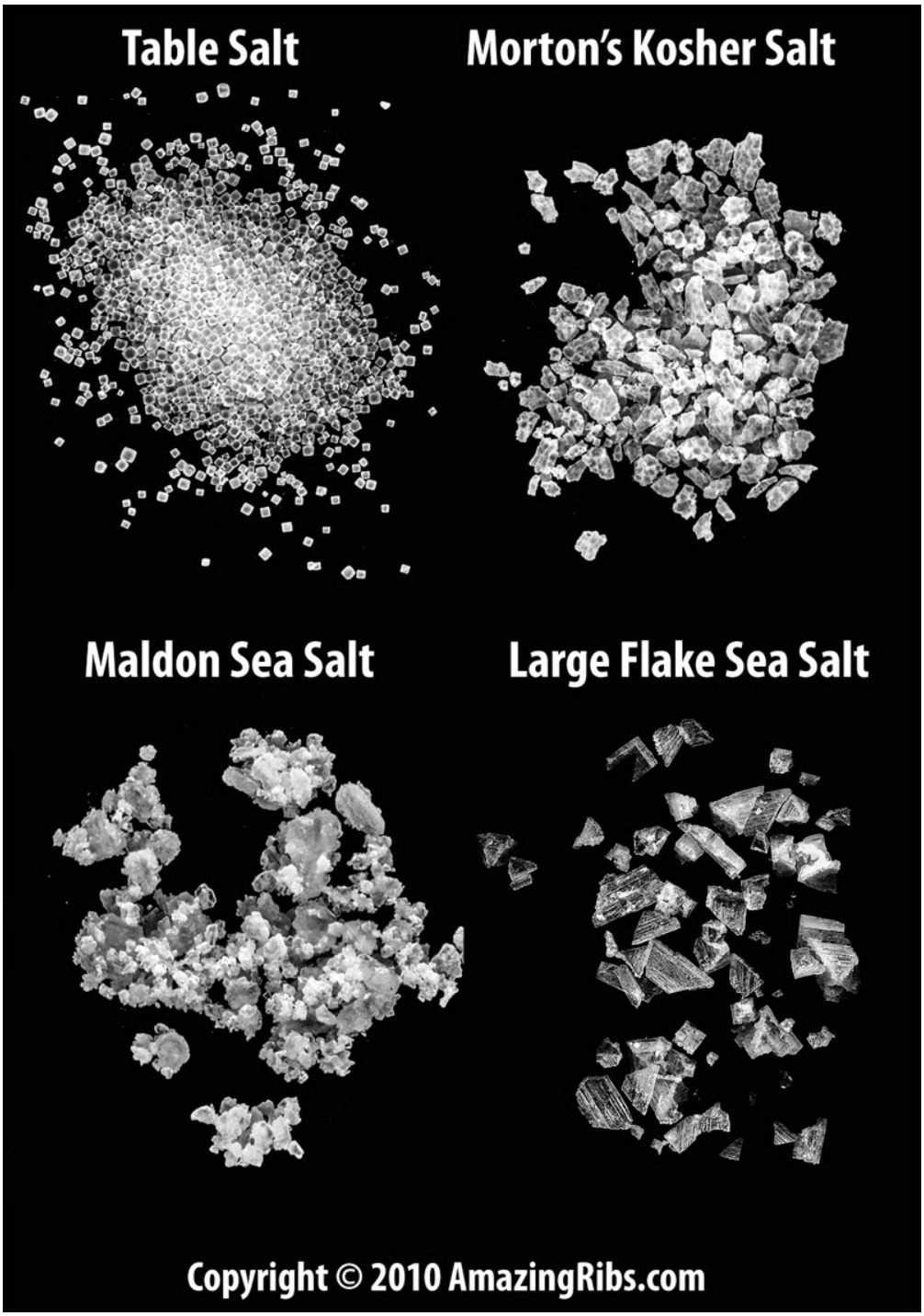
Jennifer Quinlan a food safety scientist at Drexel University in Philadelphia did some famous research in which she showed that rinsing meat aerosolizes tiny droplets of juices laden with bacteria all over the sink, faucet, surrounding counters, dish drains, and yourself.

Although she doesn’t discuss it, the problem also arises in washing your cutting board.

She recommends you do not wash meats. But we know you want to. The solution is to turn down the water pressure and be careful not to splash. Or submerge the meat or cutting board in water.

DRY BRINE

Salt (NaCl) is the magic rock. It is just two little atoms, sodium (Na) and chloride (Cl). When they get wet, they get electrically charged and they can move deep into foods. And when the food gets warm during cooking, they move even deeper. This is a good thing because salt not only amplifies foods' natural flavors without altering them, it denatures proteins and helps them hold onto moisture. A good rule of thumb is to salt meat with 1/2 teaspoon Morton's kosher salt per pound of meat in advance for about 1 hour per 1" of thickness in the refrigerator. We call this dry brining. Please note that not all salt is the same. **Click here for an interactive conversion table**.

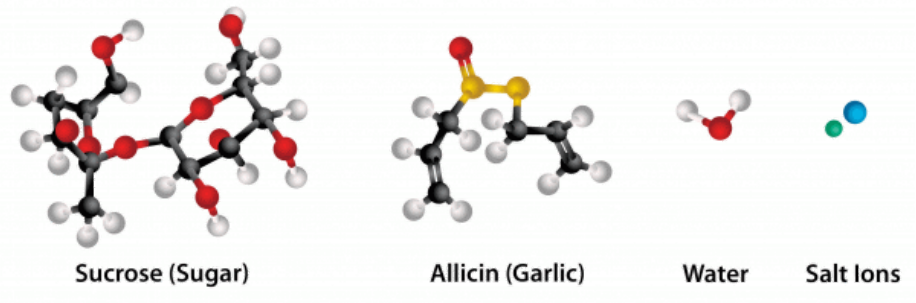


The thicker the food, the longer you need to dry brine advance. An hour or two is enough for most foods that are 2" thick or less. Turkey breasts and roasts are best salted in the morning for supper. If you salt just before cooking much of

the salt can come out and make the juice in the bag too salty for a sauce.

Yes, you can wet brine, i.e. mix salt into water and soak the food in the saline solution, but the results are pretty much the same as dry brining. Why waste so much salt and water and take up so much space in the fridge? So save some money and simply sprinkle salt on the surface.

SPICES, HERBS, AND MARINATING



It is far more effective and safer to season food after it comes out of the bag. Why? **Flavor molecules from herbs and spices are too large to penetrate much beyond the surface** of most meats (exceptions being many seafoods) so they should be seen primarily as surface treatments. If you want to flavor the meat, the right time is *after* it comes out of the bag. That's because a lot of liquid comes out of foods in the bag and they just wash off most of the flavorings.

If you don't believe me, get a pork loin hunk, say 4" long, and marinate the heck out of it. Empty the spice rack into a marinade and let it soak overnight. Then cook it, cut it in half, wipe the surface in case the knife pushed some

marinade down in, and take a core sample. Nothing but pork. No garlic, no onion, no pepper, no nothing. Except salt. Because salt is the magic rock.

Here's a chicken breast soaked several hours in a commercial marinade that we enhanced with some green dye. As you can see it is all on the surface. That's because the marinade can get into pores and cracks and fissures, but not any deeper.

And that turkey brine with all the apple juice, pepper, garlic and sugar? Wasted. Only salt will penetrate. The rest will just season the surface. If you want those flavors, put them in a rub.

As for using herbs and spices in the sous vide bag, when you pull the vacuum, they emboss their shape on the food. A lemon slice will imprint itself in a salmon. Also, spices and herbs can harbor bacterial spores.

And the oil in marinades? Who are you kidding? Meat is about 75% water. Oil and water don't mix. Don't forget, oils are solvents and can actually extract flavor from fats in the meat. Also, fat in the bag can break a sauce if you attempt to make one from the juices in the bag.

Salt is the exception. The thin white line we drew below the surface shows how far the salt penetrated. If we had let it marinate longer the salt would have marched in further, and tests by the AmazingRibs.com science advisor, **Prof. Greg Blonder** of Boston University, show that it goes even deeper while cooking.

For this reason, the best marinades are salty ones. We call them brinerades. Our faves involve soy sauces and miso.

RUBS AND PASTES

Rubs and pastes are blends of spices and herbs. Rubs are dry, pastes are rubs mixed with oil or water. You can put them on the food before you bag it, but most of them will not penetrate and a lot will come off in the purge. Also, the vacuum process can pull the oil into the area you need to seal making sealing impossible unless you switch to a larger bag. We prefer to put rubs and pastes on after the sous vide process. Just be careful about rubs with sugar if you plan to sear at a high temperature. They can burn. **We have a number of rub recipes specially formulated for beef, pork, lamb, fish, etc. on AmazingRibs.com**. In addition, **we make a line of rubs you can buy in a bottle**. And they are all salt-free which is important if you salt before cooking.

IT IS NOT BOILING FOOD!

We have a saying at AmazingRibs.com: “If you boil ribs, the terrorists win!” We say this because water is a solvent and sucks flavor from meat. That’s how you make soup. Hardcore barbecue snobs throw this line back at us when we talk about sous vide que because it is cooked in a water bath. But sous vide is absolutely not boiling! The temperature is much lower, typically 131°F to

165°F and the food never touches the water. Think of it as a water oven with precision temperature control.

CLEANING YOUR CIRCULATOR

Occasionally bags leak and juices can get into your circulator. If this happens, or even if it doesn't, you should periodically clean your circulator. Stick it in a pot with about 1 gallon of water, get it up to about 170°F, add about ½ tablespoon of dishwashing liquid per gallon, and let it circulate for about 10 minutes. If you have water that is high in calcium, it is possible that there can be buildups in the pump system. To combat this, get a small pot and add equal parts of water and distilled white vinegar. Fire up your circulator to about 150°F and let it run 10 to 15 minutes.

ENVIRONMENTAL IMPACT

You should not reuse the plastic bags, so there is environmental waste when cooking sous vide. But if you prepare foods conventionally, on a plate, sheet pan, or cutting board, you use energy to cook and wash utensils with hot water and soap. It is hard to say which produces a bigger carbon footprint. Calculations by Prof. Blonder show it's a close call. The water in the pot does not have to be wasted. Use it for watering plants once it has completely cooled.

SEARING

To see how sous vide works, let's take a tough but tasty cut of meat like flank steak, for example. From the underside of the steer, the flank is a hardworking muscle loaded with connective tissue. It is also a thin tapering muscle, usually 1/2" thick on one end and 1" thick on the other. It also often tapers on the sides. If you grill it over high heat the energy moves inward and by the time you have developed a flavorful brown crust and reached the perfect temperature in the center of the thick end, the tapered edges are overcooked. Here’s the thick end of a flank steak cooked entirely on a hot grill. Notice the layer of well-done meat below the surface. Only half the meat is perfect medium rare.

And here's what happens to the tapered end of a flank steak cooked entirely on a hot grill. Or should I say, overcooked.

But in a sous vide bath the meat warms to a uniform temperature from bumper to bumper so nothing is overcooked. Here is the interior of a sous vide flank steak cooked to 131°F and then seared over hot charcoal.

Why do we sear the meat if it is already fully cooked after the sous vide process? The problem with sous vide is, when you take the meat out of the bag, it is butt ugly and one dimensional in taste. The surface is soft and a uniform grayish tan. So much of the pleasure in food cooked with dry heat is the dark brown crust that develops when the meat is seared over direct infrared radiation or in contact with hot metal. The crust results from a chemical reaction called the Maillard reaction when heat hits amino acids and reducing

sugars creating thousands of flavorful new molecules and a crunchy surface. Plus, many of the appealing flavors of grilled and roasted meat are the flavors of the fats coming close to burning. This is what a perfectly seared steak looks like:

Not surprisingly, we prefer the flavor of the grill. Our goal is edge to edge Maillard like the picture above. Grill marks look great, but tan squares between grill marks are all lost opportunities to build flavor:

A word of caution: Beware of rubs with sugar and delicate spices like saffron. They burn easily at searing temperatures.

HOW TO SEAR ON A GRILL

First, no matter what searing method you use, you need to pat the wet meat's surface dry with paper towels so the surface doesn't steam when you blast it.

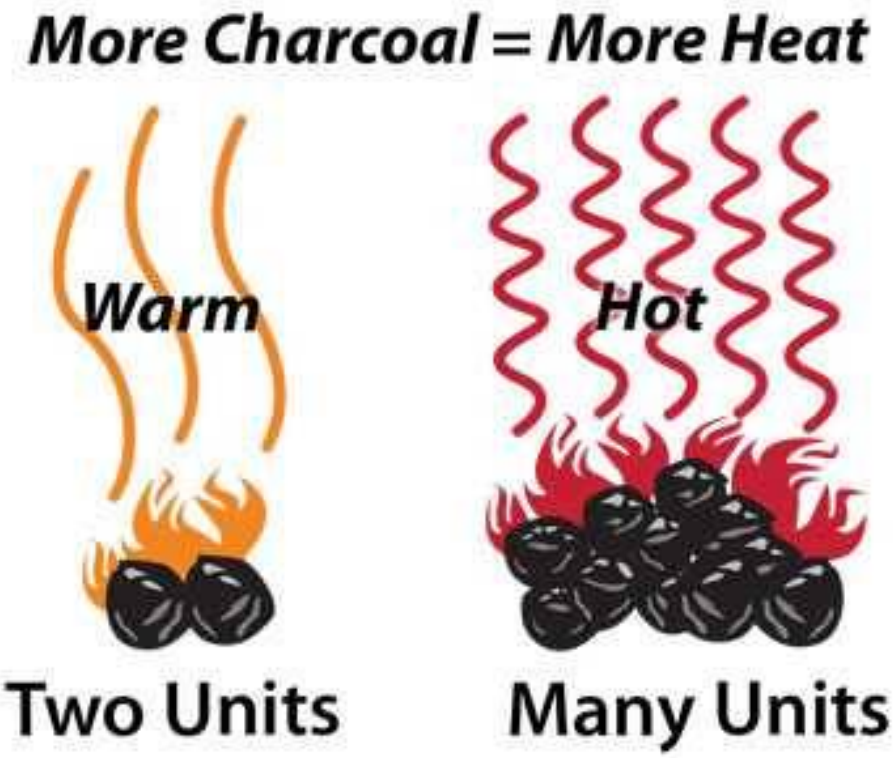
When searing on a grill, you need to expose the meat to direct infrared radiation. Hot air just doesn't do the job. It just doesn't matter how hot the thermometer on your Giant Green Avocado reads. It is measuring *air temperature* and that is not the same as measuring *energy*.

If you are not clear on the difference, do this experiment: Preheat your oven to 200°F and insert your arm. Surprisingly, you can hold it there for a while. Now place your hand on the side wall of the oven, which is also 200°F. When you get back from the hospital you will understand that the energy stored and transmitted by metal is much greater than that stored and transmitted by air even though they are both 200°F. That's why a metal pan or griddle or grill grates sear so well.

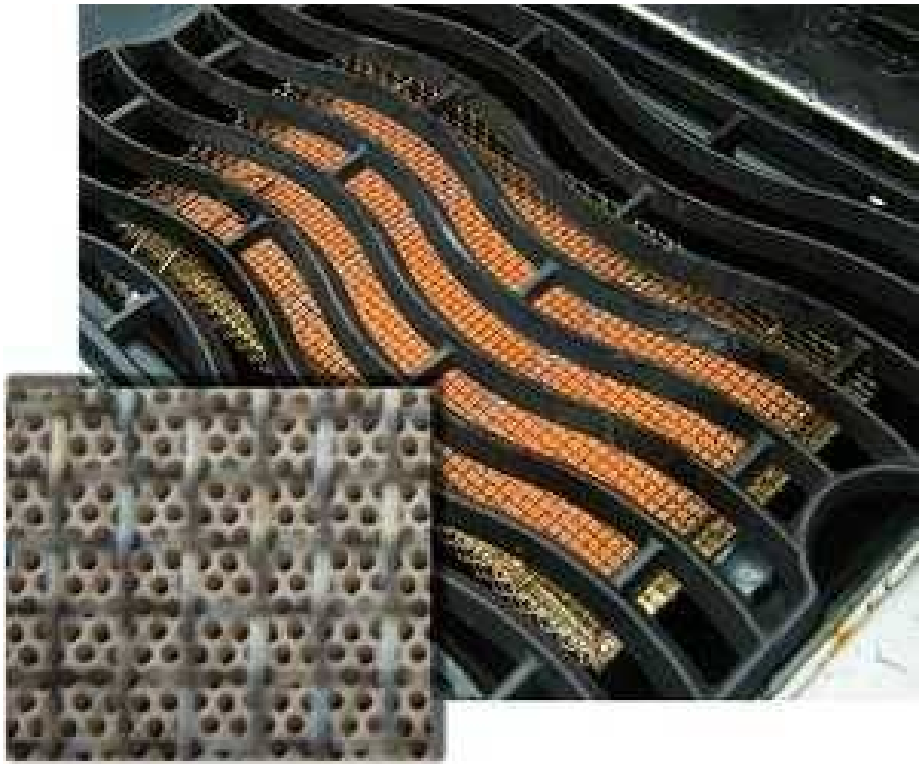
To sear on a grill, you need to expose the meat's surface to infrared radiation (IR) in the form of red glowing coals or

flame. While not as energetic as hot metal, IR transmits a lot more energy than hot air and heats food almost immediately. That's why you can get a better sear from a $30 charcoal hibachi than a $1,000 pellet "grill" which heats mostly by indirect convection air energy like an indoor oven.

We love what a charcoal grill does for sous vide. It makes top notch sous vide que. Charcoal grills generate more IR than gas grills, and the heat gets more intense as the layers of charcoal get thicker. Charcoal, especially if it is stacked 2 to 4 briquets deep, produces massive amounts of IR. Take the meat out of the sous vide bag and let it cool a bit so you don't overcook the center, pat it dry, sprinkle on a some coarse ground black pepper (remember, we salted it before it went in the bag), and then toss it over flame.



Some gas grills have “sear burners,” but few can generate the concentration of energy that charcoal produces. One exception is this sort of “infrared” burner, a ceramic honeycomb that converts gas flames into infrared radiation.



Proximity is also an important factor. The closer you are to the IR the more intense the energy is. So, in order to get a great sear, place the food directly over and as close as possible to glowing coals or flames.

Always leave the lid open so the IR is focused on one side and flip often. With the lid closed, warm air will attack the top and it can overcook the food. By leaving the lid off and flipping the food often, you allow much of the energy built up in the surface layer facing the IR to bleed off into the air when you flip, rather than push its way to the center of the food. In a few minutes, you have an extraordinarily tender steak, with a nice crisp complex sear, and a little smoky flavor.

Here is one of our favorite methods. Fill a charcoal chimney halfway to 2/3 with briquets, not lump. Because some lumps are large you don't get as much infrared as with briquets, and because briquets are uniform in size, the energy is consistent from chimney to chimney. When they are fully ignited and coated with white ash, after about 20 minutes, a column of flame roars from the top. That's some serious IR. We call it the afterburner because it looks like the backend of an F-16. Place a grid on top of the chimney and sear the heck outta that steak. For this method you need long handled tongs and you must to flip the meat every minute to avoid incineration. Watch your eyebrows and beard.

HOW TO SEAR IN A PAN OR ON A GRIDDLE

Many cooks sear in a screaming hot cast iron pan with a thin layer of high smoke point oil for as little as a minute per side. Because this can create a bit of smoke and set off smoke alarms, it is a good idea to do it on a grill, especially if it has a good side burner. Get the oil so hot that it shimmers and just begins to smoke before you put the meat in. Press it down gently so it makes contact with the pan. Boneless cuts sear better than bone-in because the bone can prevent the muscle from contacting the pan.

HOW TO SEAR WITH A TORCH

Some folks even get out a torch for searing. It works, but getting an even sear is tricky because the energy intensity depends on how close you are to the meat and even then, you don't get the deep dark sear of a hot pan or a grill. Pictured below is a **Searzall** attached to a **disposable propane tank** with a trigger ignition and a regulator such as the **Bernzomatic TS8000**. A simple **butane kitchen torch** works OK, too. Some people say they can taste propane or butane

gas, but the Searzall combusts very efficiently, and we have never noticed it.

SOUS VIDE AND SMOKE

Sous vide can also be paired with a smoker or a grill set up for smoking.

You can smoke the meat before it goes into the bag or after it is cooked. When you smoke at a low temperature such as 180 to 225°F for as little as an hour before it goes in the bag you will get a hint of smoke flavor in the finished dish, but not a lot. You will also get a bright pink smoke ring. Smoke rings

are a positive trigger to barbecue lovers, a sign that it is *real barbecue*. The smoke ring is caused by gases in smoke (NO and CO) that lock in the natural pink color of the protein myoglobin in meat preventing it from turning brown or gray during cooking. You can't get a smoke ring if you smoke after cooking because by then all the myoglobin has changed color. Alas, the smoke ring has no flavor.

Still, we prefer to smoke *after* cooking sous vide. The compounds in smoke are volatile, ephemeral, and some are water soluble. Many wash off with the purge that comes out of the meat in the bag. If you smoke long enough *after* sous vide you get a lovely seductive new layer of smoke flavor.

How long? That depends on how much you like and the type of smoke. We like a wee bit of smoke on steaks and chicken, and a lot on ribs and beef brisket. Smoke from wood chunks or chips on a gas grill is very mild. Smoke from a pellet smoker is more pronounced, but still delicate. Smoke from wood chunks on charcoal is stronger and how strong depends on how much wood you burn. Smoke from logs and wood embers is stronger still. Then there is the difference between white smoke from smoldering wood and blue smoke (almost invisible) from burning wood. The type of wood you use is also a factor, but less important than you may have been led to believe. We have a **detailed discussion of wood, combustion, and smoke on AmazingRibs.com**.

It helps that sous vide foods are wet when they come out of the bag because smoke sticks better to wet surfaces. For maximum smoke adherence, don't pat dry the food when it comes out of the sous vide bag. Just put it on the smoker or a

grill tricked out for smoking in a **2-zone setup**. Plus, because the surface is wet, evaporation cools the surface in the smoker, so the internal temperature of the meat barely rises, allowing you to maintain your preferred doneness. A good technique is to chill the meat after sous vide and before smoking, then flavor it with a rub (again, do not include salt in rubs because the meat was dry brined prior to the sous vide process), then warm it on the smoker to a pleasant sensation in the mouth, in the 120 to 140°F range, and finally hit it with a sauce. Here's a slab of sous vide baby back ribs after only an hour in the smoker. As you can see, the surface is browning and some of it is pinking.

CLOSE PROXIMITY SMOKING

This may be our favorite technique for smoking and searing. It is fast and tasty. Check out how we cooked this turkey breast. First we sous vided it at 131°F for 12 hours, then we seared it on a special grill cooking surface called **GrillGrates** with smoking **wood pellets** just a fraction of an inch below the meat. GrillGrates are an extruded aluminum cooking surface with raised rails to hold the food

and a plate below to capture and vaporize drips. The plate also has holes to allow smoke through and it evens out hot spots. Within about 10 minutes the bird had a golden hue, deep Maillard grill marks, and a seductive subtle smoke flavor. This method is also very effective on seafood which benefits from a hint of smoke, but not too much. **Here's a video of the process**.

SEARING BEFORE OR AFTER SV?

ADVANTAGES OF SEARING BEFORE SV

- Pasteurizes the surfaces and that is where most of the contamination is. But that really doesn't matter if you cook long enough.
- Builds flavor for the jus in the bag.
- Firms up the shape so soft things like fish don't get squished into funny shapes by the vacuum sealer.
- Speeds Maillard buildup at the end of the cook.

DISADVANTAGES OF SEARING OR SMOKING BEFORE SV

- Begins to cook the interior. Of course one of the primary purposes of sous vide is to prevent overcooking the interior.
- Researchers tell us that if you pre-sear, you really should chill the meat after searing to 41°F or below before vacuuming or the muscle can develop air pockets that will alter the texture. Pre-searing and

pre-smoking break water out of muscle fibers and when you attempt to vacuum seal that liquid is easily pulled out of the meat and into the bag where it can interfere with the vacuum sealing of the bag. These meats are best put in zipper bags and evacuated by Archimedes principle of displacement by submerging them in water. Alternatively, you might be able to vacuum seal if you use a long bag in order to keep the purge from traveling into the seal zone. If you pre-sear or smoke, you should consider using a zipper bag.

- Takes time.
- Gets pans or griddles dirty that must be cleaned.
- Flavor improvement is barely noticeable.

SPEEDING THINGS UP

Some advanced chefs set their water temperature 5°F higher than their target temperature for the food and then dial it back after 30 to 60 minutes because sometimes this can cut the cooking time in half. To do this properly you must use a thermometer with **a super thin probe** and **a special foam tape** on the surface of the bag to prevent leaks when the probe is inserted through the bag into the meat, as shown in the photo from PolyScience,

below. All in all, this method seems to invite more trouble than we consumers need. Sous vide cooking is not about speeding things up. It's about precise temperature control and letting the method itself do the work.

THE BIG CHILL

Before searing and saucing sous vide dishes, chefs often chill the food and hold it until needed. Then they can reheat the food in a warm water bath and/or sear it when orders are placed. This extra chilling step, they noticed, adds a little something to the finished product. It seems tastier and it seems to reabsorb some of the purge in the bag.

They take the food out of the warm water and immerse it in a 50/50 mix of water and ice in order to rapidly reduce the core temperature of the food to a safe range of 34 to 38°F. This is faster than just tossing it in the fridge or freezer because, as we know, water conducts heat better than air. Once the food has remained in the ice bath for at least 30 minutes, it can be refrigerated or frozen.

It turns out that chilling sous vide meats may have an additional benefit, according to the AmazingRibs.com Science Advisor Prof. Greg Blonder. While far from conclusive, Blonder notes that "First, as the meat is reheated, the pH begins to rise (it becomes less acidic),

thereby enhancing tenderizing enzymatic activity [enzymes are inhibited by low pH which is high acidity]. Second, tenderizing enzymes like calpain are always paired with inhibitory proteins like calpastatin. In the live animal these two are part of a regulatory cycle that keeps muscles healthy and sweeps out dead cells. Their levels are maintained in balance. When the animal dies, although no new enzymes are produced, they remain active. As you raise the temperature via the controlled water bath, enzymes increase in activity and more are released from damaged cells.

"It is possible that the antagonist calpastatin degrades more easily than calpain, leaving more calpain available to tenderize the muscle. So when you sous vide you break apart muscle because calpain is more active, and when you cool the meat it still keeps working because the inhibitory enzyme has been used up."

When it is time to serve, searing may be all that is needed to re-therm thin foods, but you may want to put it back in a water bath, oven, grill, smoker, or microwave to get it back up to a palate-friendly temperature between 130 and 140°F. Considering this potential tenderizing effect, the cook-chill-warm method is one that will certainly have an important place in the evolution and growth of sous vide que.

SAUCES FROM THE BAG

Depending on time and temperature, there is a significant amount of purge of protein laden water trapped in the bag. The quantity can be surprising, enough to completely surround the meat. One might be tempted to say the meat is braising, but braising is usually done at a simmer, at about 190°F, a much higher temperature. There

can be as much as 20% purge when cooking on a grill. It's just not visible because it falls into the fire. When cooking in a frying pan you can see it, but the water evaporates rapidly. In a roasting pan in the oven you can see it more readily. In sous vide there is little fat lost because of the low temperatures.

When you cook in a frying pan a great technique is to make a pan sauce with the purge and the brown bits stuck to the pan. They are loaded with concentrated flavors from the **Maillard reaction and caramelization**. These elements are missing in sous vide.

You might be tempted to make a sauce from the purge. Most professionals don't bother because often it doesn't work. We have had some luck making sauces from poultry purge, but no luck at all with purge from red meats. The problem is that there can be a lot of **myoglobin** and albumin, both proteins, in the purge. They coagulate when you heat the liquid to try to make a sauce. The result is mud.

If you want to try, dump the liquid in the bag into a bowl and taste it. It can be salty if you dry-brined. The spices and herbs will settle to the bottom. You can decide if you want to include them in a sauce or decant the juice off the top. There can also be a bit of fat, so you might want to chill it or use a fat separator. When you heat it, keep the temperature low. Resist the temptation to reduce the liquid.

OTHER SAUCES

There are a number of sauce recipes on AmazingRibs.com. **Here are some classic barbecue sauces**, each representative of the traditional regional sauce styles. **Here are a number of other sauce recipes** including a killer wine sauce, piccata, pesto and more. **Click here to order our bottles sauce**.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GOOD ENOUGH TO DRINK
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No waste easy squeeze bottle
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MICROBIAL SAFETY

Almost all food has microbial contamination either from the air, slaughterhouse, butcher shop, or your kitchen. Fact of life. But scientists call cooking “the kill step”. Since much sous vide cooking is being done at temperatures below those recommended by the USDA, isn’t this risky?

This is complicated stuff, and to my knowledge, definitive research on sous vide safety has not been done yet. We are not microbiologists, but we are good data miners and we have a microbiologist who advises us. After consulting with her, here is what we have learned:

Cook sous vide at 131°F or higher. At lower temperatures you may not be killing all pathogens. You may be incubating them!

USDA recommended temperatures are simplified down to a single number to make it easy for average consumers to understand. At those temperatures the meat is considered *pasteurized* almost instantly. What they don't tell you is that

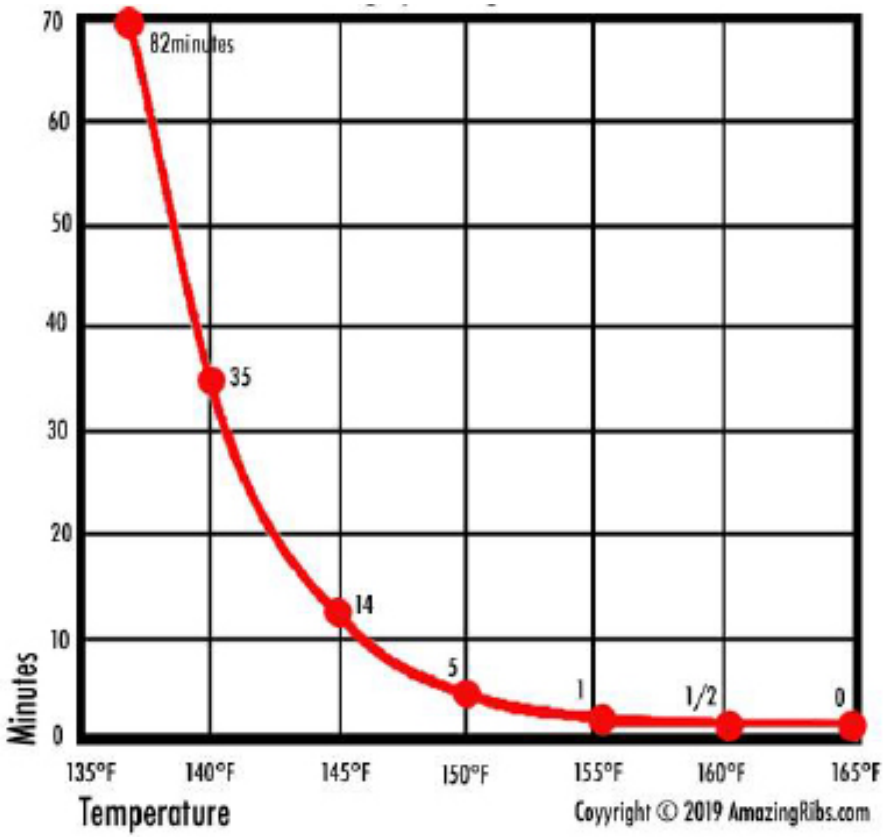
you can also pasteurize food at temperatures below their recommendations *by cooking it longer*.

That's because, in the real world, pasteurization of meat *is not just a matter of temperature*. It is a balance of all four of these variables taken together:

1. Temperature.
2. Time.
3. Load (how many bugs are there to start with).
4. Kill rate (how many remaining bugs are too few to worry about).

According to well publicized USDA info, you can pasteurize chicken or turkey instantly when the internal temperature hits 165°F. But according to USDA research that is not well publicized, it takes 27 seconds at 160°F, 5 minutes at 150°F, and 82 minutes at 136°F. So cooking below USDA recommended temperatures is safe, as long as you don't go too low or too fast. Click here for excerpts from **the USDA technical document.** Click here for **another document from USDA explaining how they came to select 165°F as the minimum temperature for poultry**.

Here is a chart of how many minutes (on the left) it takes to make a chicken or turkey safe at different temperatures (along the bottom).



Things get even more complicated. We know the definition of “sterilized” means that there are zero microbes, spores, or parasites. Zilch. None. Because sterilizing food usually involves very high temperatures, high pressure cooking, and addition of acids, all of which seriously impact palatability, we settle for pasteurized. But the definition of pasteurized is not fixed in concrete. Technically, pasteurized means that so few bugs are left that the chances of getting sick are so minute that we shouldn't worry. But how many pathogens are dangerous *for you*? Or for me? Or for an infant? Or for someone with a weakened immune system?

The USDA standard for pasteurization of meat is a kill rate of 7D or 10 to the 7th power which means that only one bad cell has survived out of 10,000,000. You need a lot more than one

cell to take out a large animal like a healthy human, so the USDA has decided that a 7D kill rate is pretty darn safe. But is it safe enough for a person in chemotherapy? For someone with AIDS? And which pathogen are we talking about? And all bets are off if it sits on the kitchen counter for an hour or so.

So who says 7D is the right number? The European Union considers 6D to be pasteurized in many cases. If you are willing to accept a 6D kill rate the time and temperature to pasteurize go down. If the meat is extremely clean to start, and if it has a very low load of pathogens, it can reach pasteurization faster.

The salient point for sous vide is that all these numbers were calculated for cooking under more common circumstances, not in a vacuum bag, and not *anaerobically* (without oxygen). Some bugs, notably the murderous strains of *Clostridium botulinum,* the bug that causes botulism, love it when you to take away the air, as you do when cooking sous vide.

Furthermore, the government numbers are based on growth rates in a lab in nutrient broth. Add salt, sugar, oil etc. and the numbers will change.

Many websites recommend sous vide cooking in the 120 to 130°F range and many people believe that bacteria can't grow at or above 120°F. This is wrong. *Most* foodborne pathogens such as *Salmonella*, *Listeria*, and pathogenic strains of *E. coli* cannot grow at or above 120°F, but some thermophilic bacteria such as *Clostridium perfringens* and *Bacillus cereus* love those temperatures.

It is important to note that some bacteria produce toxins that can outlive the bacteria themselves, remaining behind after cooking, lurking. This is why it is important to keep your refrigerator between 33 and 38°F, to not keep foods in there for long, and to not leave foods sitting out at room temperature before cooking as many recipes recommend.

Here is a table that shows the optimum growth temperatures and maximum growth temperatures of common bacterial pathogens. It does not include viruses like norovirus, the one that gets so many people on cruise ships sick, or hepatitis viruses, or parasites, some of which can be found on seafood and produce.

Pathogen	Optimum Growth	Maximum Growth
Bacillus cereus	84-106°F (29-41°C)	131°F (55°C)
Clostridium botulinum I	95-104°F (35-40°C)	122°F (50°C)
Clostridium perfringens	109-117°F (43-47°C)	122°F (50°C)
Staphylococcus aureus	99°F (37°C)	118°F (48°C)
Salmonella	95-109°F (35-43°C)	115°F (46°C)
Listeria monocytogenes	99°F (37°C)	113°F (45°C)
Clostridium botulinum II	82-86°F (28-30°C)	113°F (45°C)
Shigella	50-104°F (10-40°C)	113-117°F (45-47°C)
Campylobacter jejuni	108-109°F (42-43°C)	113°F (45°C)
Clostridium botulinum II	82-86°F (28-30°C)	113°F (45°C)
STECs (Shiga toxin producing E-coli)	95-104°F (35-40°C)	111-115°F (44-46°C

Sources:

- International Commission on Microbiological Specifications for Foods, 1996.
- Encyclopedia of Food Microbiology, 2nd Ed., Vol. 1. C.A. Batt and M. L. Tortorello, eds.

- **University of Nebraska-Lincoln Inst. of Agriculture and Natural Resources, Julie A. Albrecht, Ph.D.**

The data suggests you should cook everything at 131°F and above. Fortunately for meat lovers, 131°F is medium rare, the temperature at which most beef steaks and roasts reach optimum tenderness and juiciness, and well below the temps most of us like for pork and chicken and turkey. Even after the sear step, the internal temps of steaks usually remain under 135°F, still medium rare and very tender and juicy. So 131°F is the minimum temperature we shoot for. **For specific temperatures, check the growing section of recipes on AmazingRibs.com.**

Wait a minute, you say, most seafood is at its best at or near 125°F! The good news is that sous vide cue seafood at 131°F is still incredibly tender and juicy. But if you must cook to 125°F the better news is that *bacillus cereus*, the only bug that keeps growing at that temperature, is rare in seafood, so cooking at 125°F is still safer than eating sashimi. If you sear first you can make it even safer since searing pasteurizes the surface and bacteria rarely get into whole undamaged muscle such as a fish fillet or steak.

ABOUT SPORES

Bacillus cereus and *Clostridium botulinum* form spores under stress. Spores are like tiny fortresses that protect bacteria under extreme conditions, even boiling temperatures. You need acidity and pressure cooking at temperatures in the range of 250°F to eradicate spores. Botulinum is especially dangerous. Botulism can be fatal.

The good news is that eating spores is low risk. The acidity of your digestive system will likely kill them, and even if they should somehow activate, you will likely excrete them before they can do any harm.

Things that grow underground like garlic, onions, and carrots have more *Clostridium botulinum* spores than things that grow above ground. *Clostridium botulinum* prefers anaerobic (air free) environments. That means that throwing raw garlic in a sous vide bag or in a bottle of olive oil at room temperature increases the risk. To prevent spores from activating, do not keep foods in your refrigerator longer than 3 weeks before or after cooking and make sure your fridge is at or below 38°F.

ABOUT PARASITES

Raw seafood can harbor parasites, most commonly tapeworm eggs or larvae. Cooking to 145°F will kill adult tapeworms as well as larvae and eggs. That is hotter than most chefs like to cook fish, even with conventional cooking. Fortunately, most parasites can be killed by freezing for 7 days at -4°F or 15 hours at -35°F. Commercially frozen fish are often taken to these low temperatures. Alas, most home freezers are set to 0°F. So if you wish to cook fish to 131°F or below, you should consider buying commercially frozen fish.

ABOUT VIRUSES

Viruses are much rarer in foods than bacteria. Hepatitis A virus (HAV) or norovirus are the most common, and they come from human fecal matter, usually as a result of poor handwashing. To kill them we must cook at 194°F for 90 seconds. Cooking, sous vide or conventional, rarely goes to this temperature so the best plan is prevention by practicing proper sanitation, especially handwashing. Wiping surfaces with a chlorine based sanitizer is effective. USDA recommends a solution of one tablespoon of 5% unscented, liquid chlorine bleach per gallon of water. Vinegar will not do the job.

LET'S BUST SOME MYTHS

There is a lot of mythology surrounding sous vide.

- No matter what you've heard, you cannot leave meat in the bath as long as you want. It can dry out. Yes, food swimming in purge in a bag can get dry because proteins shrink and they squeeze out moisture. They can also break down and degrade.
- No matter what you've heard, there is no single perfect temperature for cooking things.
- No matter what you've heard, searing first does not make a big difference.
- No matter what you've heard, oil in the bag does not make a big difference.
- No matter what you've heard, spices and herbs in the bag do not make a big difference.
- No matter what you've heard, cooking in a bag does not prevent loss of liquid or flavor.
- No matter what you've heard, you do not need a vacuum sealer.

- We’ve heard manufacturers say “Having company over? You don’t have to be slaving in the kitchen while they are enjoying cocktails. Join them yet still have confidence that all the components of the meal will come out perfect.” That may be true if you have four sous vide machines chugging away on the meat, veggies, potatoes, and dessert, and if you don’t plan to sear them or sauce them.
- I have heard sous vide experts say that one of the advantages of sous vide is that there is more flavor because it is all trapped in the bag. When grilling or cooking on a stovetop or oven, they say, you can smell the flavor molecules escaping. Nonsense. There is an awful lot of very flavorful juice in the bag after sous vide. When cooking a 12 ounce hunk of brisket flat at 155°F, there was 4.5 ounces (by weight) of purge expelled.

ON THE OTHER HAND

On AmazingRibs.com we are strong advocates of a method called reverse sear, a.k.a. "redneck sous vide," and we recommend it for most foods more than 1" thick. Even baked potatoes. The concept is simple. As with sous vide, we cook the inside and outside separately. But instead of searing the outside first and then letting the surface heat cook the center as in normal grilling, we reverse the process. We start by gently warming the food to cook the center at a low temperature in a 2-zone setup in indirect warm convection airflow. *Then* we finish by subjecting the exterior to intense infrared energy over flame or glowing coals to create a great crust.

Way back in 2013 when Meathead got his first sous vide machine, he pitted the two methods against each other. He cut two thick bone-in ribeye steaks from the same prime rib roast. He started one in a sous vide bath at 131°F and after a few hours, placed the other on the indirect side of a charcoal grill at 225°F. When the grilled steak hit 131°F, he placed both steaks directly over hot coals to sear them. Here are results.

The sous vide steak is on the left. As you can see, the reverse seared steak on the right is a very different color. That's because it was exposed to small amounts of smoke from the charcoal throughout the cook. Compounds in smoke vapors lock in the pink color of the pink protein myoglobin in the meat, giving it a pinker tone. The crust was also heartier and thicker due to greater surface dehydration in the grill. Notice that it also has lost a bit more surface fat because it was cooked at a higher temperature. You can see that especially well in the area near where the bone is connected to the meat.

As for juiciness, there is a lot of water loss with both cooking methods. With any cooking method, if you weigh the meat before and after, you will notice that it can lose as much as 20% of its weight to purge. Well, for sous vide, there is also a

lot of purge in the bag when you take the meat out. How much depends on the cooking temperature and time. Sous vide cooking a ribeye steak to 140°F or grilling it to 140°F can produce twice as much purge as sous vide or grilling it to 130°F. Not to worry. Beef is about 70% water and, as Meathead explains in **his article questioning the need to rest meat after cooking**, juiciness depends on much more than water.

There were noticeable differences in the mouth. The sous vide steak was more tender and slightly more juicy. But the reverse sear steak was definitely more flavorful. Although it was firmer and slightly less juicy, it was by no means tough or dry. Which was better? He preferred the reverse sear. But you might prefer the sous vide. As the French say "*chacun à son goût*," each one to his taste.

IS SOUS VIDE A FAD?

Skeptics say this too will pass, like fondue pots and slow cookers. Both boomed when new, and now sit in the pantry and come out only a few times a year. Then there is the microwave oven. Few people prepare whole meals in them, but many of us use them regularly to defrost and reheat, to melt chocolate, and aid with other cooking techniques. What will be the impact of time on sous vide?

Sous vide is not new. Experiments began in the late 1960s. The first public sous vide meal was almost certainly served at the Holiday Inn in Greensboro, SC, in 1970 by Ambrose T. McGuckian. He had been an employee of Grace Cryovac, makers of commercial vacuum sealing systems, and was involved in programs to improve hospital food with NASA. Big advances in the method were made in the 1970s by Dr. Bruno Goussault, a brilliant French scientist, and Joel Robuchon, a brilliant French chef. But the original equipment was bulky, expensive, and complicated. It caught on with restaurants, especially those that served large parties. But it wasn't practical for home cooks.

In the past few years, the prices of sous vide machines have dropped, the equipment has become easier to use, and software has made it easier to find the right time and temperature. More and more foodies are using this method on a regular basis. If you're serving a crowd, it really simplifies things because most of the cooking is done ahead — and without your attention. As with a pellet smoker, once your sous vide set up is ready to go, you can "set it and forget it."

Because it is new, somewhat technical, requires special equipment, and comes with conflicting guidance on proper cooking times and temperatures, sous vide will not likely be adopted by the majority of American households. Without a doubt, it will be used extensively by restaurateurs and caterers. In fact, it already is. If a chef has a dinner in her hotel ballroom that calls for 400 filets mignon cooked to perfection, all you need is sous vide and a large flattop or grill to sear.

Is the sous vide machine the next fondue pot? The cool wedding gift you use a few times and then it goes in the attic? Is it the next slow cooker or InstaPot? To be used only 3 to 4 times per year and buried in the pantry for months at a time?

At the current price point, we suspect millions will be sold in the coming years. But because the food must be submerged up to 24 hours in advance, many of us just won't plan far enough ahead. And because it works better on some foods than others, we won't use sous vide for everything. The many different temperatures and times and techniques could

make it too complicated for home cooks. But perhaps the superior precision and the convenience factor will make it worthwhile in the end. Just like a crock pot.

But what if we are have our sous vide machine working on some beef short ribs at 145°F for 24 hours for dinner tomorrow night, how are we going to get a batch of steaks going at 131°F for dinner tonight?

We think it will eventually become a common appliance in many homes. We think you will figure out which dishes you like and add them to your repertoire. In the end, we'll probably use it more often than the fondue pot and slow cooker combined. Every night? Maybe not.

PART VII
TIME AND TEMP GUIDELINES

The trick to sous vide success is dialing in your preferred temperatures and times. The problem is, there is no one single combo. And there are so many contradictory charts and recipes out there. As an example, here are some recommendations for pork ribs from top experts:

- Jason Logsdon, sous vide pioneer and author, says 140°F for 1 or 2 days for "chop-like" ribs and 156°F for 18 to 36 hours for more fall apart ribs.
- Philip Preston, sous vide pioneer from PolyScience, a producer of circulators and other sous vide tools, says 145°F for 24 hours.
- J. Kenji López-Alt **tested pork ribs for SeriousEats.com**. He recommended two versions, 145°F for 36 hours for ribs that are "extra meaty, like a pork chop" or 165°F for 12 hours for ribs that are more "traditional barbecue style".
- Chef Andrew Zimmern says 152°F for 18 hours.

- Grant Crilly of ChefSteps, makers of Joule, says 162°F for 4.5 hours.
- Doug Baldwin, scientist, book author, and another pioneer, does his at 175°F for 8 to 12 hours.

Many circulators come with an app with recommended time and temp settings. Keep in mind, these are not dictum from high above. They are chosen by trial and error by the chefs who made the app. And taste is a matter of taste. There is no one perfect setting for everyone. If your machine is app-less or it isn't detailed enough for you, **SousVide Dash** is an iOS app that is well respected. Another app is **Sous Vide Toolbox by PolyScience**. In addition there are several good books and websites that we recommend in the section titled **"For More Info"** below.

But you need a starting place. In selecting a temperature, remember you have a lot of leeway. To simplify things for you, we put foods in two basic groups, Tender Cuts and Tough Cuts. Start there. And remember, you can always pull the bag out of the bath while it is cooking and squeeze the meat to feel how tender it is.

The thing to remember is that the texture of the food changes with the temperature and time in the pouch. And variables such as how much connective tissue and marbling can significantly impact the results. So one combination of time and temp might work great for USDA Choice grass finished Hereford sirloin, and another will be better for USDA Prime grain finished Black Angus ribeye.

Below are our recommended temperatures and times as starting points that will produce meats that we are confident will please you. We have simplified things a lot. As you practice you will learn which time and temperature combos work for *your* tastes, just like you learned which cut of steak you like best and what temperature you prefer. Experiment! Keep a notebook!

TENDER CUTS

"Tender Cuts" includes foods that are relatively tender and are usually cooked to less than 160°F when not cooked sous vide. Pick the doneness temperature you like for any food in the Tender Cuts group on the chart and the cooking time depends mostly on thickness. Yes, fat content, connective tissues, and water content are factors, but let's not complicate things by throwing those variables into the works.

So, how do you like your steak? Medium rare, medium, medium-well, or well-done? And pork chops? Wellllll, if you've never tasted a pink pork chop cooked to 135°F to 145°F (medium) you have never tasted pork. Even though it is pink, it is perfectly safe. Chicken? You have been forced to destroy it all your life because the contamination rate is so high (90% of all chicken has pathogenic bacteria according to *Consumer Reports*). That's why you must cook it way past well-done to 160°F. Just lowering it a notch to 155°F, or heaven forbid, 150°F, where there is still some pink to the flesh, and you are in for an all new experience.

How long to cook foods in the Tender Cuts group? Here's a rule of thumb: Use the chart above to pick the same temperature you like when cooking conventionally and cook sous vide at about 5°F less for about 90 minutes per 1" thick, then sear or smoke. Taste it and make adjustments on the next cook.

TEMPERATURES FOR TENDER CUTS

Beef, Lamb, Venison, Duck Breasts (Steaks, Chops, Roasts)	
Blue, "Pittsburgh"	110-120°F (43-49°C)
Rare	120-130°F (49-54°C)
CHEF TEMP Medium Rare	130-135°F (54-57°C)
Medium	135-145°F (57-63°C)
Medium Well	145-155°F (63-68°C)
Well Done	155°F (68°C) or more
Pork, Raw Ham, Veal (Steaks, Chops, Roasts)	
Rare	120-130°F (49-54°C)
Medium Rare	130-135°F (54-57°C)
CHEF TEMP Medium	135-145°F (57-63°C)
Medium Well	145-155°F (63-68°C)
Well Done	155°F (68°C) or more
Chicken, Turkey (Whole Or Ground), Including Stuffing	
SV TEMP Medium Well	150-155°F (66-68°C)
CHEF TEMP White Meat Well Done	160°F (71°C)
CHEF TEMP Dark Meat Well Done	170°F (77°C)
Ground Meats & Raw Sausages	
SV TEMP Medium	145°F (63°C)
Tuna & Lobster	
CHEF TEMP Rare	120-125°F (49-52°C)
Other Fin Fish	
CHEF TEMP Medium Rare	125-135°F (52-57°C)
Hams, Hot Dogs, Precooked Sausages	
CHEF & SV TEMP Warm	140°F (60°C) or more

1 - Cook. Salt, then sous vide for 2-4 hours at the temp at left.

2 - Optional. Chill thoroughly in the bag.

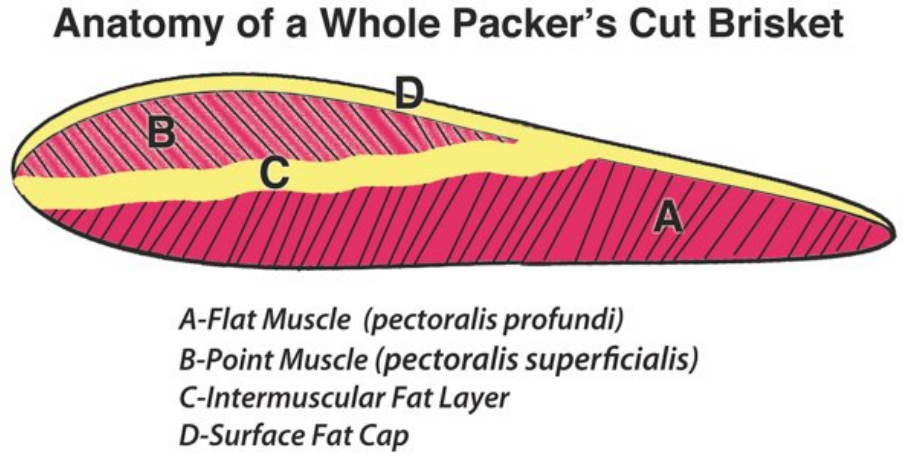
3 - Rub. Remove from bag, pat dry, sprinkle generously with salt-free rub or lightly with salted rub.

4 - Finish. Sear in a hot pan, griddle, or on a grill until you like it, or smoke at 225°F (107°C) and then sear. Bring to the temp at left. Glaze or sauce if you wish.

TOUGH CUTS

These are the big tough barbecue cuts like pork ribs, pork shoulders, beef briskets, and beef ribs. These are hardworking muscles and notoriously tough cuts that pitmasters typically smoke roast between 225 and 275°F for a long time until they hit an internal temperature of 190 to 205°F. Fortunately, sous vide is incredibly good at breaking down these tough muscles and making them tender. Hard core pitmasters are amazed at the texture of barbecue cuts cooked sous vide. Unfortunately, although the flavor profile can be excellent, nobody will mistake sous vide que pork or beef for real smoke roasted barbecue. So you need to make a decision: Smoke flavor or tenderness.

You don’t have to cook the brisket or pork butt whole! And you shouldn’t. Brisket point, the muscle on top, is a lot fattier and absolutely should be cooked separately. Its composition is a lot different than the flat, which is lean and much tougher. If you separate the two muscles, you’ll find the point is ready much sooner than the flat.



The reason we smoke huge cuts low and slow for eight hours or more is because it takes a long time to melt connective tissues, render fat, and tenderize. Cut them into smaller chunks, and they tend to dry out because of the increased surface area for evaporation. With sous vide, not a problem! Low and slow is the rule of the day and a brisket flat cut into six chunks will still be as tender and juicy as a whole smoked packer's cut brisket.

Sous vide times and temperatures for these meats can really vary depending on how much connective tissue, fat content, thickness, and most of all, your preferences.

How long to cook Tough Cuts? Here's a rule of thumb:

Sous vide at 145°F to 150°F for 24 hours.

Taste and make adjustments on the next cook.

1 - Cook. Salt, then sous vide at 145°F (63°C) for about 24 hours.

2 - Optional. Chill thoroughly in the bag.

3 - Rub. Remove from bag, leave wet, sprinkle generously with salt-free rub or lightly with salted rub.

4 - Roast or smoke. Roast or smoke at 225°F (107°C) until 145-155°F (63-68°C).

5 - Optional. Thoroughly dry the surface. Sear in a hot pan, griddle or on a grill. Glaze or sauce if you wish.

TIPS

- Use fresh quality ingredients. Sous vide tends to amplify defects, so if your pork has been in the freezer too long and the fat is getting rancid, it will get worse in the bag.
- For food safety, you should not cook at temperatures lower than 131°F. After that, pick the temperature and time from the guide that will deliver the texture you like best.
- The thicker the food, the tougher the cut, the longer it takes to cook.
- Don’t start timing until the water is up to temperature.
- You can sous vide frozen food direct from the freezer. Add an hour or two.
- Poultry skins tend to saturate with liquid and may get too soft to crisp during searing. Try removing them before sous vide and sear or fry them into crunchy flavorful cracklins, crumble them, and sprinkle on the cooked meat.

TENDER CUT EXAMPLE: STEAK RECIPE

We often lie awake at night dreaming of the perfect steak, an intoxicating mouthful of flavor with every bite. Tender as a love ballad, juicy as a Georgia peach, with a crisp crust that deftly balances smoke and seasoning to create a steak that puts even the finest steakhouse to shame. Sous vide que to the rescue.

By following the sous vide, rapid chill, smoke, and reverse sear method, you may just make the best ribeye you ever tasted. Try this and then make your sous vide machine earn out its purchase price and cook a tougher cut like flank steak, London broil, merlot steak, hanger steak, or anything from the rump.

Makes. 2 steaks, 2 to 4 servings

Takes. 2 hours to sous vide, 1 hour to chill, approximately 20 minutes to smoke and sear

Ingredients

1 (1.5" thick) beef steak

Morton Coarse Kosher Salt

Method

1| Prepare a sous vide immersion circulator and set the water temperature for 131°F.

2| Season the steak with about ½ teaspoon of Morton's kosher salt per pound of meat. Seal it in a sous vide bag and if you can, let it dry brine for an hour or two. Then sous vide for 2 hours.

3| Prior to the end of the sous vide process, fill a large container with a 50/50 mix of ice and water. Once the steak is finished, still in the bag, place it in the ice water for 30 to 60 minutes to quickly lower the meat's core temperature.

Place the steaks in the refrigerator until ready to grill (up to a week ahead of time).

4| Prepare a grill for **2-zone cooking**. On a charcoal grill, place a chimney full of pre-heated charcoal briquets to one side of the grill. You want one side scorching hot and the other side at about 225°F. Add 2 to 3 chunks of your favorite smoking wood to the charcoal for smoke flavor. On a gas grill, adjust the temperature knobs so that one half of the grill is as hot as possible and the other half is approximately 225°F.

5| Once the grill is ready, remove the chilled steak from the bag and place it on the indirect convection heat side of the grill as far away from the heat source as possible. Place the lid on the grill with the top vent fully opened and positioned directly above the steak in order to force the smoke over and around the meat. Allow the steak to smoke until it reaches an internal temperature of about 115°F on **a good digital thermometer**.

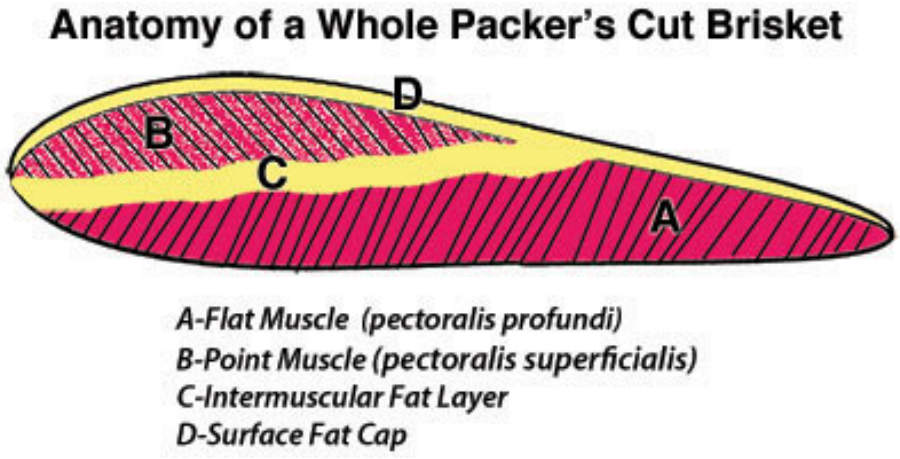
6| Once the steak reaches 120°F, remove the lid, move the steak directly above the heat source as close as you can get to it and sear the steaks while frequently flipping until an even dark crust has formed. At this point, the internal temperature of the steaks should be in the medium rare range, 130 to 135°F. It is best to aim for the lower temperature in order to avoid possible overcooking during carryover.

TOUGH CUT EXAMPLE: BEEF BRISKET

For an experienced Texas pitmaster, transforming this tough cut of beef into a masterpiece requires nothing more than a simple salt and pepper rub, some post oak smoke (or another favored smoking wood), and 12+

hours of low heat and TLC. On the other hand, for those who only cook one or two briskets a year, adding liquid injections and using the "Texas crutch" (foil-wrapping) are commonplace strategies that ensure moist, tender, and flavorful results. You can read more about these practices in our article "**BBQ Beef Brisket Texas Style, the Definitive Guide"**.

Brisket has two muscles, and one is nicely marbled, the point, and the other is very lean and ornery, the flat. Sous vide que is also a low and slow cooking process that breaks down the brisket's tough connective tissues and it is perfect for the leaner part of the brisket, the flat.



Once the water bath cooking is complete, you rapidly cool the brisket in a 50/50 mix of water and ice. Cooling it down ensure that the meat can be smoked on the grill without drying it out. Or, if you want to make it ahead of time, you can refrigerate the cooled-down brisket for several days. Note that there will be approximately one to two cups of flavorful liquid left in the bag after for sauce.

To complete the brisket, you only need to smoke it briefly with your favorite smoking wood to add a true barbecue flavor. Since the brisket has already been fully cooked during the sous vide step, there is no need to smoke it beyond an internal temperature of 125°F (51.7°C), at which point it will be pleasantly warm when eaten.

Once smoked, be sure to slice the brisket against the natural grain of the meat to cut across the tough muscle fibers and ensure maximum tenderness for your anxiously waiting family and/or guests. Do note that since the brisket isn't cooked entirely on the grill or smoker, it won't have the same heavy bark you'd expect on traditional brisket. That said, you're sure to love the end product equally if not more!

Ingredients

6 pound beef brisket flat

3 teaspoons Morton Coarse Kosher Salt (approximately 1/2 teaspoon per pound (453.6 g) of meat)

3 teaspoons coarse ground black pepper (feel free to substitute our **Big Bad Beef Rub**)

About the salt. *Remember, kosher salt is half the concentration of table salt so if you use table salt, use half as much.* ***Click here*** *to read more about salt and how it works. For this recipe, you want to use 1/2 teaspoon Morton coarse kosher salt per pound (453.6 g) of meat.*

Method

1| Prep. Trim off most of the fat cap but leave about 1/4-inch. Season the brisket with kosher salt. If you can, refrigerate the brisket uncovered for 12 to 24 hours to give the salt time to be absorbed. The process of salting in advance is called **dry brining**. The rule of thumb is 1/2 teaspoon of kosher salt per pound of meat.

2| Cook. Prepare a sous vide immersion circulator and set the water temperature for 145°F. Place the whole brisket in a jumbo 2- or 2.5-gallon sealable storage bag. Alternatively you can divide the brisket into two halves and place each half in a separate 1 gallon size sealable bag. Use a vacuum sealer or carefully submerge the freezer bag in the water bath until the air has been removed and then seal the bag. Completely submerge the sealed bag, and cook the brisket for 24 to 30 hours.

3| Chill. Once the brisket has finishing cooking, remove the bag from the water and submerge in a large container filled with a 50/50 mix of ice and water until the meat's core

temperature reaches a safe range of 34-38°F, at least 30 minutes. At this point, the brisket can be refrigerated until you are ready to smoke it (several days ahead of time) or frozen.

4| Fire up. Prepare a smoker for indirect cooking, adjusting the vents to maintain a temperature of approximately 225°F (107.2°C). If you're using a charcoal grill, prepare it for **2-zone cooking** by placing a chimney full of pre-heated charcoal briquets on one side of the charcoal grate to create direct and indirect cooking zones. Adjust the grill vents to bring the temperature to about 225°F (107.2°C). Add 2 to 3 chunks of your favorite smoking wood to the charcoal for flavor. On a gas grill, adjust the temperature knobs so that one half of the grill is off (the indirect side) and the other half is heated enough to maintain a temperature of approximately 225°F (107.2°C) on the indirect side, adding wood chunks or chips to the direct side.

5| Smoke. Once the smoker or grill is ready, remove the brisket from the bag and season liberally with either coarse ground black pepper for a traditional Texas-style brisket or **Big Bad Beef Rub**. Place it on the smoker. The liquid in the bag can be refrigerated for future use. If you're using a grill, place the meat on the cooler side of the grill as far away from the heat source as possible. Set the lid on the grill with the top vent fully open and positioned directly above the brisket in order to force the smoke over and around the meat. Allow the brisket to smoke until it reaches an internal temperature of 131°F (51.7°C), about 2 hours. Note that the interior of the brisket will already be perfectly cooked from the sous vide step. The goal is to simply reheat and smoke the brisket without overcooking it

6| Serve. Remove the brisket from the smoker or grill, slice it against the grain, and serve immediately.

FOR MORE RECIPES

We are constantly experimenting and tweaking recipes, so we have included only two detailed recipes here, the ones we know you want the most, because they illustrate so much of what we have discussed above. We think the guidelines in the "**Time And Temperature**" section should be all the recipes you need to venture forth with success.

We have many more detailed and tested recipes by our team on AmazingRibs.com here. Also, our Pitmaster Club forum also has a number of sous vide que recipes from some pretty skilled cooks who are adding more all the time. Non-members are allowed to view 3 free pages or you can sign up for a free 30 day trial membership. We don't ask for your credit card. **Click here to check out the benefits of membership**.

Just for fun, here are some quick non-meat recipes:

- **Eggs.** Want eggs with firm whites and runny yolks? 145°F for an hour.

- **Carrots.** Carrots start to get tender after 45 to 60 minutes at 185°F depending on thickness. To puree them, 195°F.
- **Green beans.** Green beans and other firm green veggies (not leaves) get soft after about 30 minutes at 180°F.
- **Fruits for pie fillings.** Sous vide at less than 185°F so pectin will retain its ability to set the filling.
- **Cocktails.** Alcohol boils at about 173°F so if you are infusing a cocktail keep the temp down under 170°F to make sure the bag doesn't explode from alcohol fumes.

FOR MORE INFO

A lot has been written on sous vide in the past five years. Many hobbyist bloggers are not sufficiently informed on methods, especially the crucial microbiology guidance, which we pioneered. Nailing a recipe takes experimenting, research, and practice. Many bloggers and home recipe writers cannot be trusted. Here are some highly reliable references.

AmazingRibs.com is our website and we have lots more info and tested sous vide que recipes, many from our resident sous vide que guru, **Clint Cantwell**. Ask him anything. **Subscribe to our free monthly email newsletter, Smoke Signals** and we will send you announcements of new recipes.

The AmazingRibs.com Pitmaster Club has a busy forum on sous vide que with some pretty skilled cooks participating. Non-members are allowed 3 free pages or you can sign up for a free 30 day trial membership. Membership is only $23.95 per year.

Anova Culinary is the website of the Anova immersion circulators, and it has a lively community and recipes by **J.**

Kenji López-Alt.

Dr. Douglas Baldwin is the author of a great book and website.

ChefSteps.com is the website of the brilliant chefs who created Joule. Lots of tips and recipes. ChefSteps was recently acquired by Breville.

PolyScience makes machines aimed at the professional. Owned by Breville.

Immersed is the excellent highly technical book with killer looking precision recipes **Philip Preston**, The founder of **PolyScience**.

Champions of Sous Vide is the latest book with a collection of some great recipes from 24 sous vide all-Stars. The authors, Mike La Charite and Jason Logsdon sponsor the only annual sous vide conference and Meathead is a regular speaker. Info is at the **International Sous Vide Association** website.

SeriousEats.com has an excellent sous vide section with tested recipes, many by the esteemed **J. Kenji López-Alt**. He is also a *New York Times* columnist.

PART VIII
CHECK THIS OUT

Here are some goodies from AmazingRibs.com

MEATHEAD'S AMAZING SEASONINGS & DRY BRINES

Many meals ago, in 2005, my neighbor challenged me to a rib cookoff. I won, got a swelled head, and built a website to share my "secrets." Now, according to Forbes, Meathead's AmazingRibs.com is "By far the leading

resource for BBQ and grilling information" and I am in the Barbecue Hall of Fame.

Since I founded the site in 2005 I have shared more than a dozen of our favorite rub and sauce recipes for free, like the ones on the previous pages, and they have become hugely popular. All of them have won big bucks in competitions and been used in restaurants. Finally, after 16 years, in November 2021, we listened to your requests and created three bottled rubs and a sauce under the name "Meathead's Amazing." They are based on our free recipes, but have several new ingredients and changes.

Why there is salt in these rubs? When you make rubs at home, we recommend you do not add salt because salt penetrates and none of the other spices and herbs do, so thick cuts need more salt. We put salt in these bottled rubs because all commercial rubs have salt and without salt the price would be outlandish. Also, without salt buyers would wonder why their food needs salt. You can still use these as a dry brine, just sprinkle the rub on well in advance to give the salt time to penetrate. For very thick cuts of meat, we recommend adding a bit more salt. Click here to order them.

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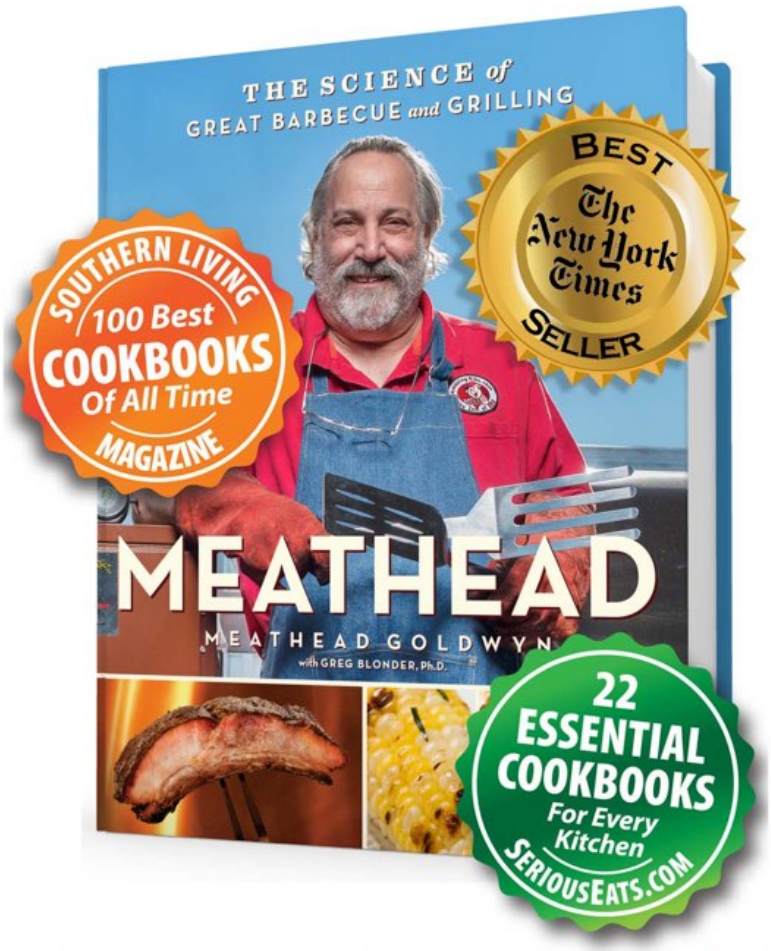

Meathead, The Science of Great Barbecue And Grilling

"100 Best Cookbooks Of All Time" Southern Living

New York Times Best Seller

3,047 ratings on Amazon ★★★★★

Meathead's
AMAZINGRIBS.COM FOOD TEMPERATURE GUIDE
"By far the leading resource for BBQ and grilling information" Forbes

Beef, Lamb, Venison, Duck Breasts (Steaks, Chops, Roasts) - USDA Minimum 145°F (63°C)			A
Blue, "Pittsburgh"	110-120°F (43-49°C)	Dark purple, cool, stringy, slippery, slightly juicy	
Rare	120-130°F (49-54°C)	Bright purple to red, warm, tender, juicy	
CHEF TEMP Medium Rare	130-135°F (54-57°C)	Bright red, warm, tender, very juicy	
Medium	135-145°F (57-63°C)	Deep pink, yielding, juicy	
Medium Well	145-155°F (63-68°C)	Slight pink, some tan, firm, slightly fibrous, moist	
Well Done	155°F (68°C) or more	Tan to brown, no pink, chewy, dry	
Pork, Raw Ham, Veal (Steaks, Chops, Roasts) - USDA Minimum 145°F (63°C)			A
Rare	120-130°F (49-54°C)	Pale pink center, warm, tender, slightly juicy	
Medium Rare	130-135°F (54-57°C)	Creamy pink color, bouncy, very juicy	
CHEF TEMP Medium	135-145°F (57-63°C)	Cream color, some pink, yielding, juicy	
Medium Well	145-155°F (63-68°C)	Cream color, firm, slightly juicy	
Well Done	155°F (68°C) or more	Cream color, tough, dry	
Chicken, Turkey (Whole Or Ground), Including Stuffing - USDA Minimum 165°F (74°C)			A
SV TEMP Medium Well	150-155°F (66-68°C)	Cream color white meat, pale tan dark meat, tender	
CHEF TEMP Well Done	160°F (71°C)	Cream color white meat, pale tan dark meat, firm	
Ground Meats & Raw Sausages - USDA Minimum 160°F (71°C)			A
SV TEMP Medium	145°F (63°C)		
Grill or pan fry these risky meats to	160°F (71°C) and make them juicy by using a 20 to 30% fat blend		
Tuna - USDA Minimum 145°F (63°C)			A
CHEF TEMP Rare	120-125°F (49-52°C)	Bright reddish purple	
Other Fin Fish - USDA Minimum 145°F (63°C)			A
CHEF TEMP Medium Rare	125-135°F (52-57°C)	Slightly translucent, flaky, tender	
Lobster, Crabs, Crawfish, Shrimp, Scallops - USDA/CHEF/SV TEMP When opaque 131°F (55°C)			A
Hams, Hot Dogs, Precooked Sausages - USDA Minimum 140°F (60°C)			A
CHEF & SV TEMP Warm	140°F (60°C) or more	Tender, juicy	
BBQ/Roasted Ribs, Shoulders, Briskets, Legs, Rumps - USDA Minimum 145°F (63°C)			B
CHEF TEMP Tender, Tugs Apart	203°F (95°C)	High in fat and collagen, best cooked low and slow	
Clams, Oysters, Mussels - USDA/CHEF/SV TEMP When shells open			
Leftovers - USDA/CHEF/SV TEMP Minimum 165°F (74°C)			

Other Useful Temperatures

0°F (-18°C) Best freezer temperature.
25°F (-4°C) Meat freezes.
32°F (0°C) Water freezes.
34-39°F (1-4°C) Best refrigerator temperature.
41-130°F (5-54°C) Danger zone in which many pathogenic bacteria grow.
130-135°F (54-57°C) Medium rare, most meats are most tender and juicy.
131°F (55°C) Most pathogenic bacteria begin to die. Minimum sous vide temp.
135°F (57°C) Connective tissues begin to contract and squeeze out pink juice.
150-165°F (66-74°C) Large cuts at low temps stall and do not rise for hours.
160°F (71°C) Soft boiled eggs.
160-165°F (71-74°C) Instant kill zone. Most pathogens die in seconds.
160-205°F (71-96°C) Collagens melt, form gelatin, making meat succulent.
170-180°F (77-82°C) Custards begin to set.
173°F (78°C) Alcohol begins to boil.
180-185°F (82-85°C) Water begins to simmer.
185°F (85°C) Custards begin to break.
190-200°F (87-93°C) Most breads are done baking.
210°F (100°C) Baked potatoes are fluffy.
212°F (100°C) Sea level boiling point. Subtract 2°F every 1000' above.
225°F (107°C) Best temp for low & slow roasting tough cuts of meats - 8.
310°F (154°C) Maillard browning accelerates.
325°F (163°C) Minimum cooking temp for browning poultry skins.
425°F (281°C) Teflon thermometer cables can melt.
450°F (232°C) Teflon pans can emit toxic gases.
500-700°F (299-399°C) Hardwoods start to smoke.
700-1000°F (399-538°C) Hardwood gases produce flame.

Fats & Oils

95-130°F (35-54°C) Animal fats start to soften and melt.
300°F (149°C) Butter starts to smoke.
325-375°F (163-191°C) Extra virgin olive oil begins to smoke.
350-375°F (177-191°C) Best oil temp for most deep frying.
361°F (183°C) Some animal fats begins to smoke.
370°F (185°C) Lard begins to smoke.
375-400°F (190-205°C) Virgin avocado oil begins to smoke.
390°F (199°C) Grapeseed oil begins to smoke.
400°F (204°C) Canola oil begins to smoke.
400-450°F (205-230°C) Vegetable oil begins to smoke.
440°F (227°C) Inexpensive olive oil and sunflower oil begin to smoke.
450°F (232°C) Peanut oil, corn oil, soybean oil begin to smoke.
482°F (250°C) Ghee begins to smoke.
510°F (265°C) Safflower oil begins to smoke.

Sugar

217-222°F (103-106°C) Target temp for most jams and jellies.
230-234°F (110-112°C) Thread Stage. Sucrose (table sugar) melts and makes syrup. Fructose starts to caramelize.
235-240°F (113-116°C) Soft Ball Stage. For fudge, pralines.
244-250°F (118-121°C) Firm Ball Stage. For caramels.
250-265°F (121-130°C) Hard Ball Stage. For nougat.
270-290°F (132-143°C) Soft Crack Stage. For taffy.
300-310°F (149-154°C) Hard Crack Stage. For brittles, lollipops.
320-350°F (160-177°C) Clear Liquid Stage. Caramelizes.
350°F (177°C) Burnt Sugar Stage. Starts to burn and tastes bitter.

SOUS VIDE (SV) RULES OF THUMB

These times and temps are **starting points** that will produce meats that please. Experiment!

A - TENDER CUTS

1 - Cook. Salt, then sous vide for 2-4 hours at the temp at left.

2 - Optional. Chill thoroughly in the bag.

3 - Rub. Remove from bag, pat dry, sprinkle generously with salt-free rub or lightly with salted rub.

4 - Finish. Sear in a hot pan, griddle, or on a grill until you like it, or smoke at 225°F (107°C) and then sear. Bring to the temp at left. Glaze or sauce if you wish.

B - TOUGH CUTS

1 - Cook. Salt, then sous vide at 145°F (63°C) for about 24 hours.

2 - Optional. Chill thoroughly in the bag.

3 - Rub. Remove from bag, leave wet, sprinkle generously with salt-free rub or lightly with salted rub.

4 - Roast or smoke. Roast or smoke at 225°F (107°C) until 145-155°F (63-68°C).

5 - Optional. Thoroughly dry the surface. Sear in a hot pan, griddle or on a grill. Glaze or sauce if you wish.

For ratings and reviews of more than 150 accurate, inexpensive digital thermometers and BBQ thermostats visit: AmazingRibs.com/thermometers

Much more info on Meathead's AmazingRibs.com
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Order our Award Winning Food Temperature Guide. This 8.5 x 11" magnet has more that 80 benchmark temperatures for meats (USDA recommended temps as well as the temps chefs recommend), fats and oils, sugars, sous vide, freezer and fridge temps, eggs, collagens, wood combustion, breads, and more.

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