

Fermentation and Cheesemaking

A course in biology and food science and deliciousness

Offered as part of the curriculum of the Associate's Degree in Sustainable Food & Agriculture at Northeast Wisconsin Technical College

Offered as part of the 'SARE Organic Academy' for teachers in Summer 2021

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Instructor's notes

- When you see a text box with instructor's notes, feel free to delete it or hide it from what students will see.
- These are notes to help you do little things to teach the course well.

Cheesemaking and Fermentation

Course overview & lesson 1



Why teach fermentation & cheesemaking?

- Cheesemaking is cool
- Fermentation is cool too – but unfamiliar
- Most people don't know that cheese making is a subset of fermentation processes.
- Fermentation teaches some great biological principles
- Many people don't realize they can learn to ferment foods themselves and save a lot of money and make better products.
- Fermentation teaches us to make friends with microbes & bacteria
- Fermentation has a great deal of importance and was therefore included as a part of the curriculum for a sustainable food and ag systems associate degree at Northeast Wisconsin Technical College

In this course:

- In lesson 1 we learn about fermentation and make sauerkraut
- We will ferment milk in lesson 2 and make yogurt
- We will practice cheese making in lessons 3,4,5
- We will explore fermentation of other carbohydrates (grains and sugar) in lesson 6
- In lesson 7 we will take a tasting tour of the cheeses and fermentation products from around the world.
- Lesson 8, is a review and final exam

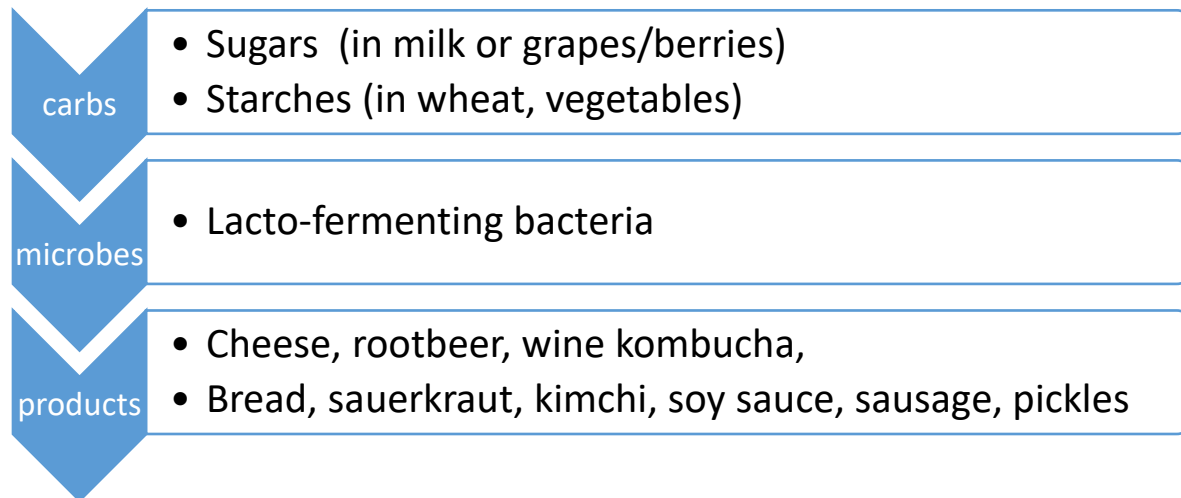
Fermentation – lesson one

- ✓ Background, historical context, food preservation
- ✓ Good Bacteria and our gut health. (Bacteria R us)
- ✓ How does fermentation work?

Fermentation – what is it anyway?

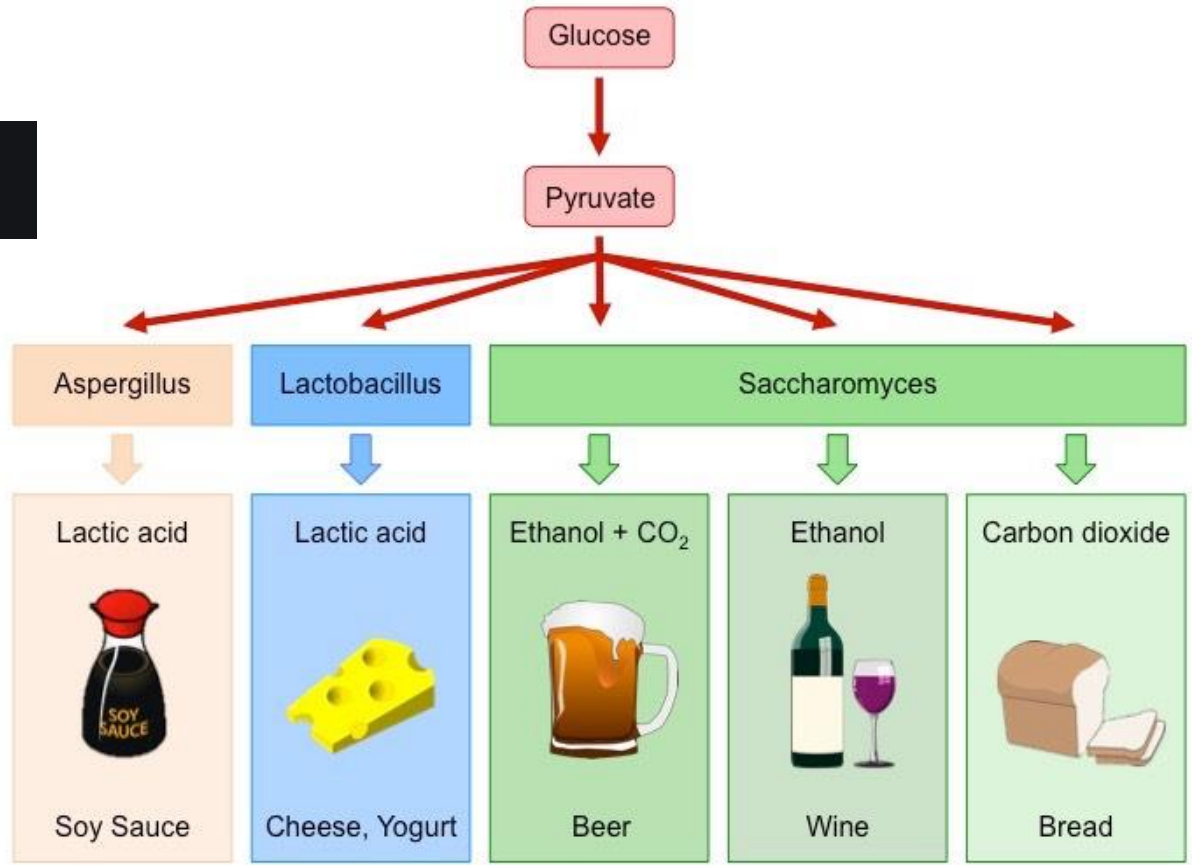
- A **process** in which a
- **Carbohydrate**
- Is turned into:
 - An either a **product** with alcohol + CO₂
 - or a product that was coagulated by a weak acid

We will dig more deeply into this topic shortly.



Examples of food products of fermentation

BioNinja
Yeast Fermentation | BioNinja



Background & History of fermentation

- How did humans preserve food for the last 10,000 years?
- How did humans preserve food in the last 80 years?
- What does it mean to preserve food anyway?

Instructor notes: Have students try to answer these questions by listing food preservation methods as a warm- up for class.

Preservation methods in the last 10,000 years

- Salting
- Sugaring
- Drying
- Smoking
- Fermenting

What do all these methods have in common?

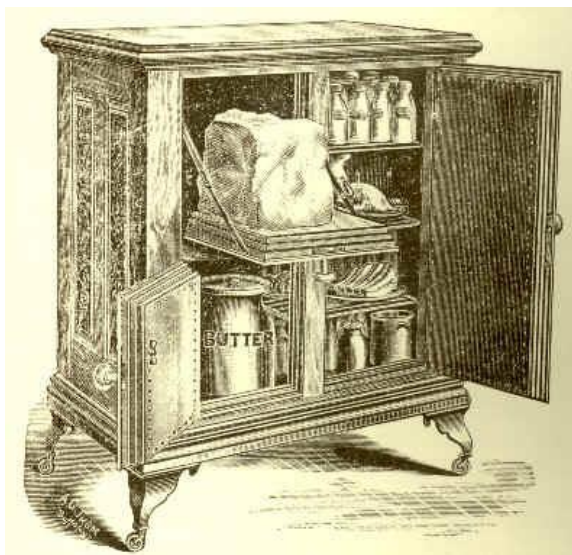
These are methods to keep out & destroy bad bacteria so our food is not degraded or 'spoiled'.

Preservation in the last 80 years - MODERN

- Canning – killing bacteria & mold by heat
 - Freezing, refrigeration – retarding growth of microbes
 - Additives (BHT, etc.) – retarding growth
 - Pasteurization – killing with heat
 - Irradiation – killing by ionizing radiation
-
- Question: what do all these methods require that older methods do not?
 - Hint: it has to do with sustainability

Electricity!

- Canning requires a more constant high heat than what a simple cooking fire can achieve. That's why canning is a 'new' technique.
- Before refrigeration ice was used for a part of the summer in "ice boxes" in northern climates to keep food cold.



What is food preservation?

- Processes designed to keep “bad” bacteria from spoiling our food.
- Old methods like salting, sugaring, smoking, and drying make food an inhospitable environment for most bacteria.



Bacteria like warm, moist conditions

- Keeping food either dry, or cold with smoking, drying, freezing, refrigeration.
- Or use osmotic pressure – salting and sugaring which actually are ways to ‘dry’ the food so that bacteria cannot thrive.



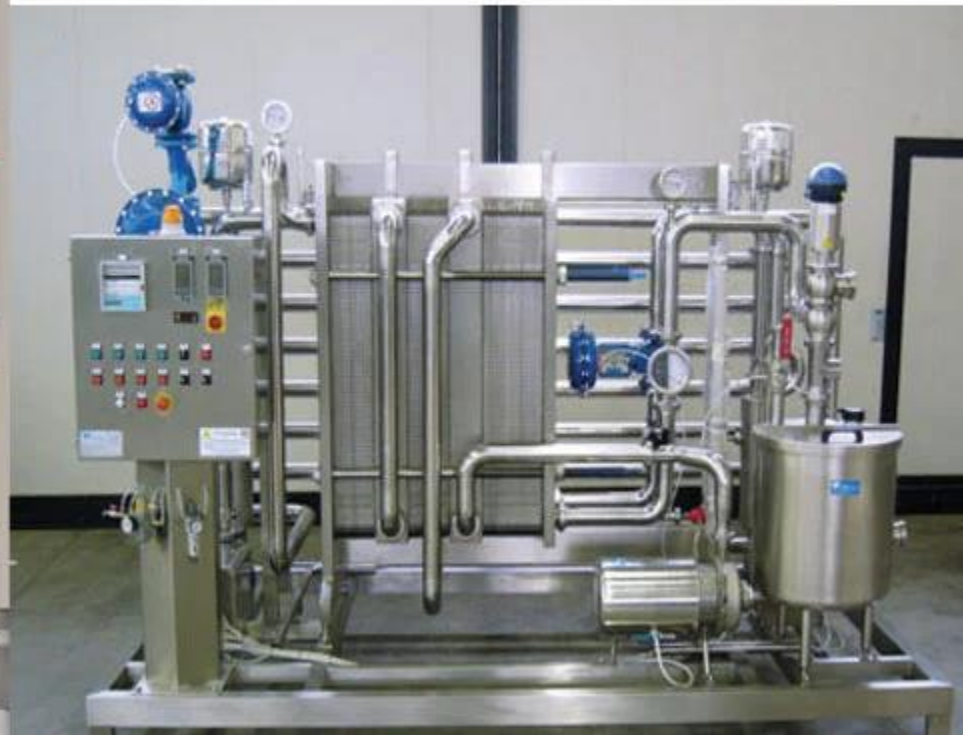
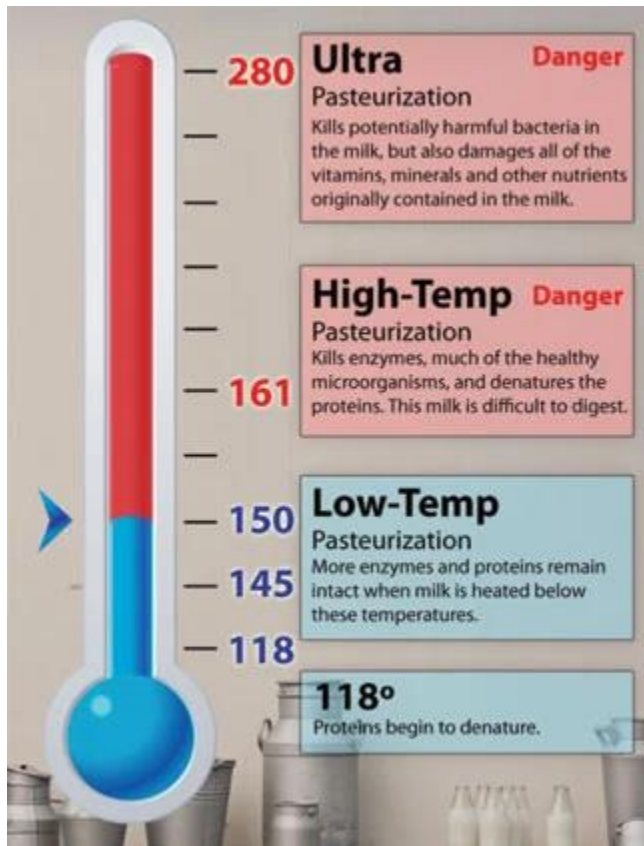
Modern preservation

- Stops most all bacteria - both the bad and the good
- Typically through heating or cooling the product:
 - ✓ Canning, is sterilizing a jar of food then sealing it
 - ✓ Pasteurization - dairy – kills pathogens – milk lasts 2-3 weeks in the fridge
 - ✓ Ultra High Temp (UHT) milk is sterilized milk
 - ✓ (do not bring this kind of milk in to class!) Lasts 2-3 months w/o refrigeration



Fermentation occurs at 80-110 degrees

Milk Pasteurization



Milk pasteurization

Loius Pasteur patented heating as a way to kill bacteria in wine in 1865.

Pasteurization typically uses temperatures below boiling, since milk curdles at very high temperatures

- Home pasteurization of raw milk: heat milk at 145 °F (63 °C) for 30 minutes. (or 165 degrees for 15 seconds)
- HTST (High Temp, Short time) Heated to 72 °C (161 °F) for 15 seconds.
- HHST Higher Heat shorter time 191 for 1 second
- UHT (ultra high temp) processing holds the milk at a temperature of 138 °C (280 °F) for a minimum of two seconds

Pasteurization is good & bad

- Good; kills pathogenic bacteria from dirty farms
- Bad
- kills all bacteria, even the beneficial ones
- Can denature proteins
- Denatures some enzymes that help you digest
- It does not make cheese because it is denatured or ‘broken bonds’.
- UHT Gives a cooked or caramelized flavor to milk

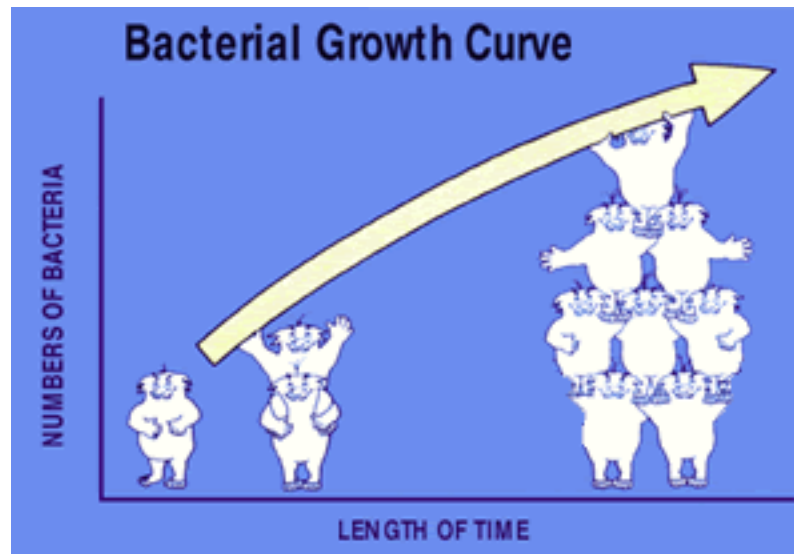
Raw milk

- Raw milk is milk that has not been pasteurized.
- I use this kind of milk from my goat for making cheese.
- I drink raw milk and fed raw cow's milk to my children when they were young.
- Use good, clean technique when milking but trust that good bacteria outnumber and outcompete bad actors.



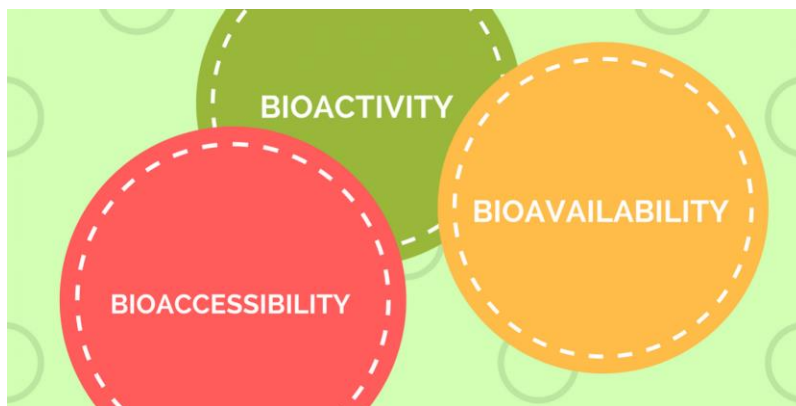
Moving on from the previous food preservation methods to fermentation

- Fermentation does not seek to destroy all bacteria
- It actually fosters and multiplies beneficial bacteria
- We hold temperatures at 85-110 degrees to help grow the bacteria we want.



Modern preservation vs. fermentation

- Fermentation of food enhances nutrient availability and digestibility.
- Modern preservation (killing) methods often degrade vitamins, enzymes and nutrients as well as their availability.
- Modern processing and additives may retard our digestion of food.
- Fermentation is sustainable because it doesn't have to use electricity



Fermentation

- Fermentation favors colonization by an overwhelming population of good bacteria in order to crowd out the bad bacteria.



We may get one bad apple type bacteria.....
But the overwhelming number of bacteria in our food are good.

The importance of fermentation

- Fermentation **adds** good bacteria to our colon.
- Its time we stopped being afraid of **all** bacteria
- Bacteria are important for digestive health.

• Preservation by lack of (killing) all bacteria is not equivalent to preservation by encouraging growth of good bacteria.



Connecting fermentation to health

- Let's explore the connection between food, fermentation, bacteria and our health.
- First we look at a story showing that even just 200 years ago we didn't know how food became digested and entered our body.
- Next, we'll look at the role that good bacteria play in digestion.
- Finally, we look at the chemistry of fermentation – how do microbes ferment and preserve food for us?

Understanding the gut

Just 200 years ago much was unknown

- The story of Alexis St. Martin & Dr. William Beaumont shows how recently we've learned how digestion works
- At Fort Mackinaw Island in the Upper Peninsula - June 6 1822
- St. Martin, a young voyageur and a fur trapper, was accidentally shot at close range by a buddy (or some versions of the story say they were drunk and a cannon ball was involved)...anyway, Dr. Beaumont (who later became a physician in Green Bay – there is still a clinic and a street named after him) saved his life but couldn't close the hole in his stomach.
- The hole literally became a window for the Doctor to understand how a stomach digests food. Here is a great link to the story on YouTube



<https://www.youtube.com/watch?v=pAKtZOQLmeE>

Instructor notes: Students really like this story, especially if you are in NE Wisconsin, because of Beaumont's connections. The point of the story is that we still are learning about the role of food and digestion. Prior to Beaumont, it wasn't known how food actually fed us.

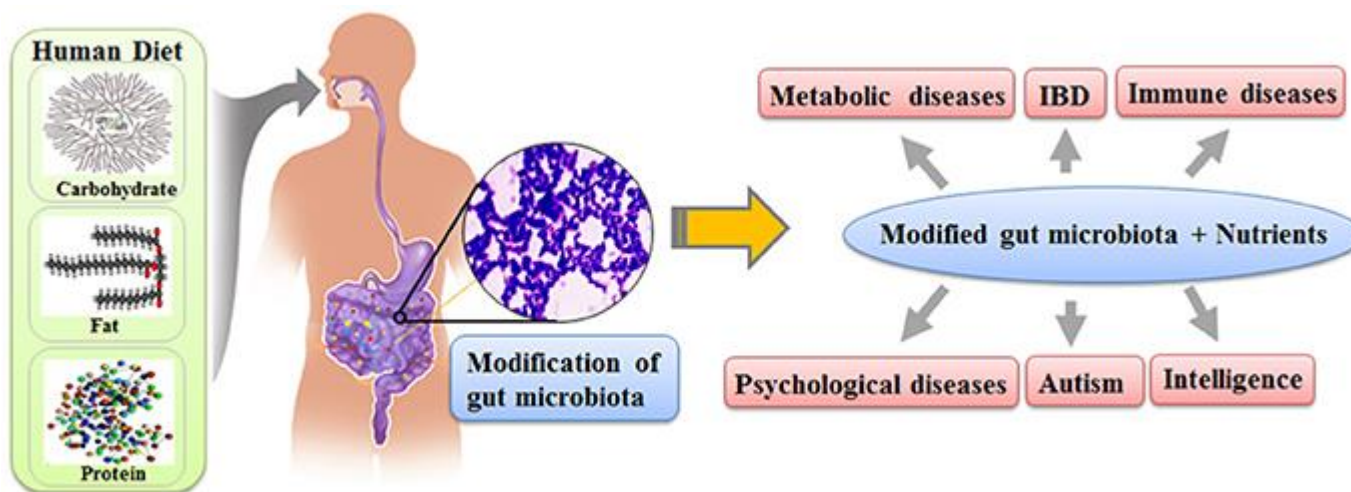
Understanding the gut

- We thought we've learned a lot about the way digestion and health work since Beaumont's time, but the last 15 years have brought huge advances in understanding that we need GOOD gut bacteria as partners in digestion in order to be healthy.
- Listen to NPR Radio Lab story about gut microbiome

<https://www.npr.org/sections/health-shots/2013/11/01/242361826/exploring-the-invisible-universe-that-lives-on-us-and-in-us/>

Food preservation consequences

- How we preserve our food has received little attention compared to other dietary concerns.
- It's as if our guts and their microbial ecology doesn't matter.
- But when our gut-microbe partners are messed up, things can go wrong.



The bacteria in our body is a terrarium in our tummy.

- Ruminants like cows aren't the only creatures with gut bacteria
- We are all carrying around bacteria in our guts, this is normal and natural
- Have you ever had a gut feeling? We are more tied to our gut bacteria than we ever imagined previously
- Will bacteria help my immune system?
- Am I what I eat?
- The American Gut Project investigates which microbes make us healthy, which make us sick how can we optimize our guts for better health.
- Some doctors are even doing fecal transplants to move good gut microbes from healthy people to sick people.

My body is what % bacteria?

(facts from Prevention Magazine 8/2013)

- “We are more microbe than we are person”
- Our bodies contain 10x more bacteria than human cells.
- 100 trillion microbes in and on us.
- “The size of a small dog” Rob Dunn, PhD.
- Most (about 3 lbs) are in and around our guts

- Gut feelings
- Pro-biotics
- Colon = colony? Of bacteria

Our intestines communicate with our brains.

What does this have to do with fermentation – why should you care?

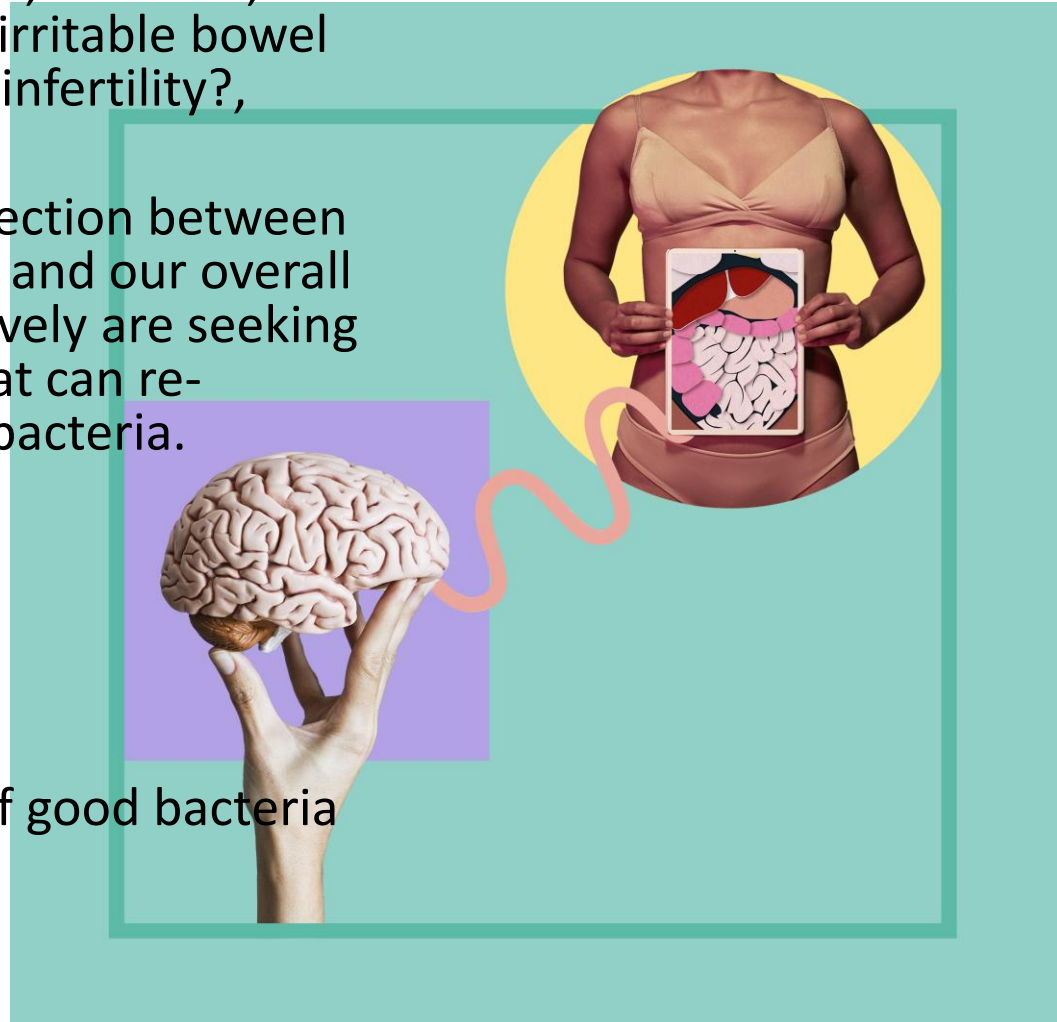
Gut diseases of the western diet:

Celiac-sprue, gluten intolerance, diabetes, obesity, Krohn's, colitis, ulcers, irritable bowel syndrome, autism (leaky guts), infertility?, MRSA,more....?

The jury is still out on the connection between gut health (with good bacteria) and our overall health, but many people intuitively are seeking food that is more 'alive' and that can re-inoculate their guts with good bacteria.

Research between brain-gut connections is exploding.

Fermented foods are sources of good bacteria



Dr. Tieraona Low Dog says



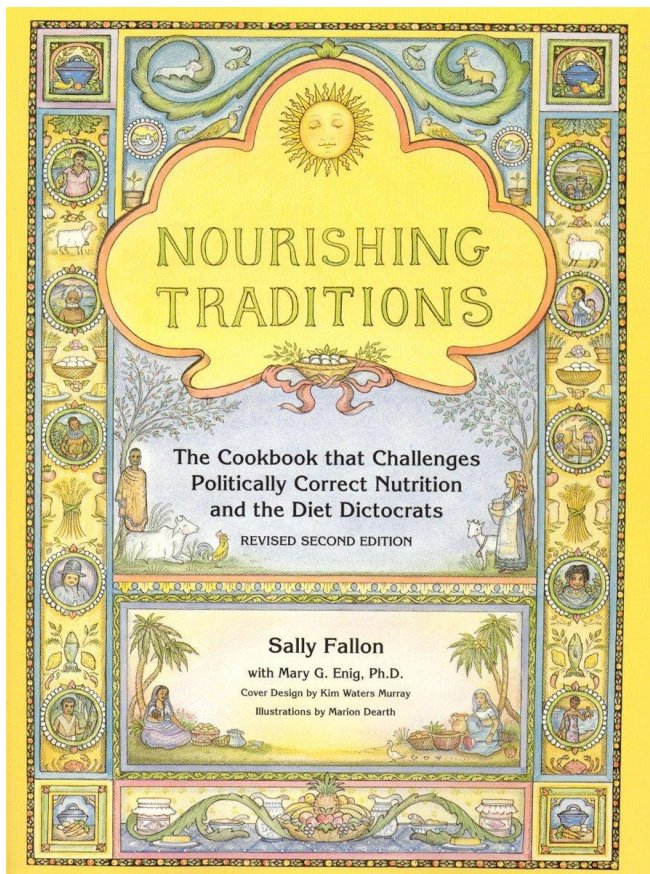
Over 2000 years ago, Hippocrates declared that “All disease begins in the gut.” Indeed today, many of the chronic diseases we face link directly to our gut health. In fact, 75 million Americans suffer from heartburn, over 24 million suffer from Irritable Bowel Syndrome, and another 30% live with chronic indigestion. And more than \$18 billion is spent annually on managing chronic indigestion with generally poor results.

Nourishing Traditions by Sally Fallon

- Humans are born with innate vibrant health
- Our diets of refined carbs, the wrong fats and oils, lack of bone broths, and Are full of dead foods.

Lack of fermented foods

May make us vulnerable to many illnesses.



Get fermented foods into your diet

- In the olden days, condiments were made of ‘small ferments’.
- Ketchup was ‘kecap’ fermented fish sauce and full of good bacteria.
- Now, ketchup is high fructose corn syrup, tomatoes and vinegar ...not fermented
- Ketchup is a table condiment. The unmodified term ("ketchup") now typically refers to tomato ketchup,[1] although original recipes used egg whites, mushrooms, oysters, grapes, mussels, or walnuts, among other ingredients.[2][3] - wikipedia

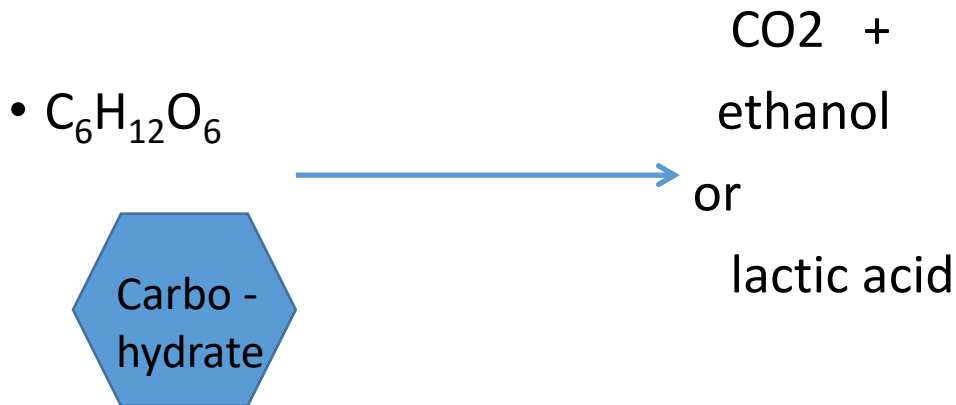


What is fermentation?

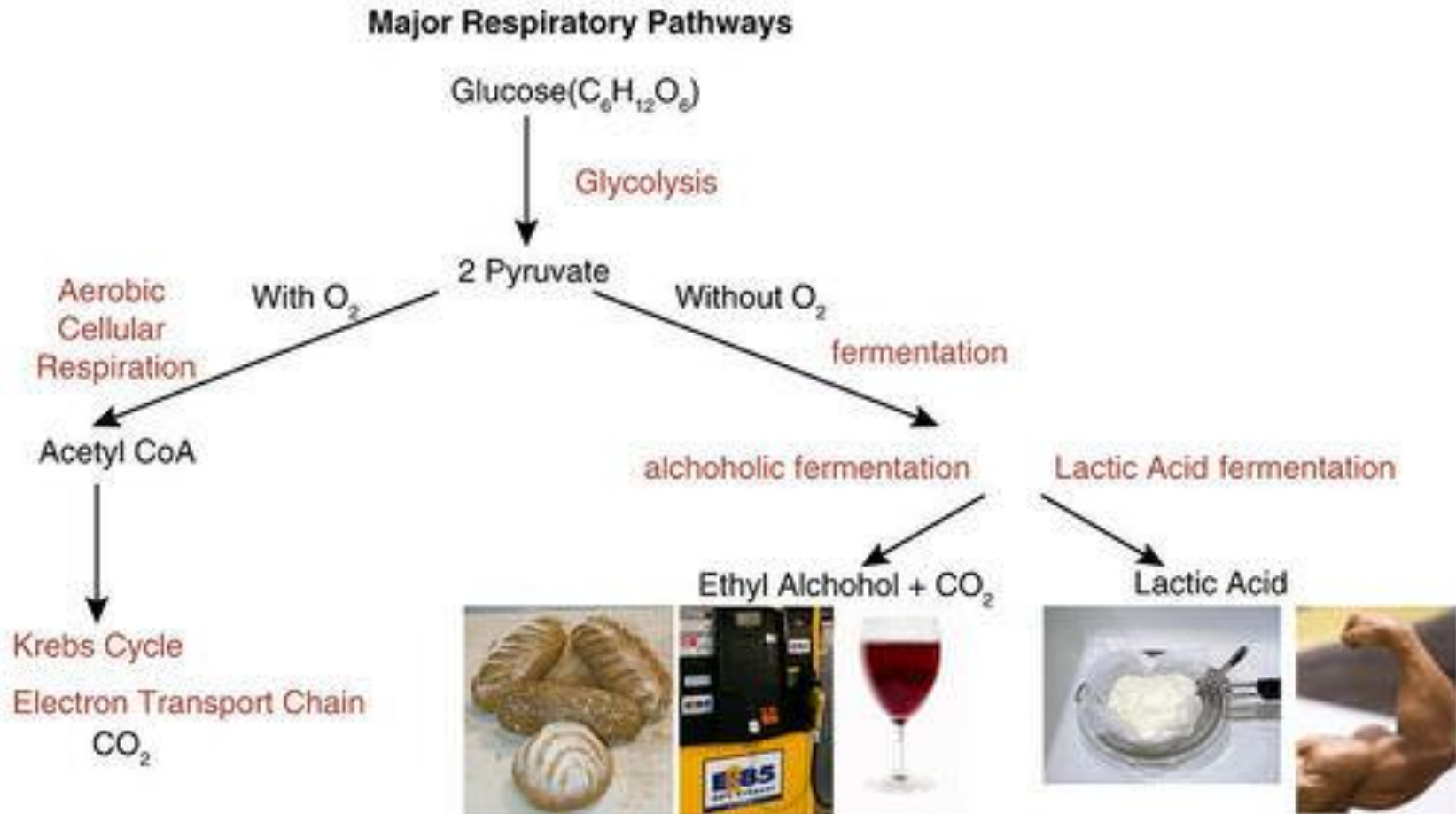


Fermentation – what is it anyway?

- A process in which a
- Carbohydrate
- Is turned into
- An (alcohol + CO₂) or an acid
- Occurs in the absence of oxygen, it's anaerobic



Biochemistry of fermentation



Who or what powers the process?



Micro-organisms

These are the agents that spin straw into gold, barley into beer, wheat into bread, grapes into wine and milk into cheese.

- Bacteria
- Molds
- Yeasts
- (we explore these microbes more in detail in another lesson)

- Why do they do this? What's in it for them?

Why they do it?

- They get energy from the process.
- They invest an ATP and get 2 ATPs back.
- They double their investment
- Smart microbes!

Why do we care? What do we get?

- We get two things from our little helpers:

either _____ and _____

or

Alcohol and CO₂

Or

Lactic acid



- CO_2 is carbon dioxide
- It makes bubbles
- It causes breads to rise
- Beverages to sparkle

(root beer bubbles ...but fermentation is stopped before the sugars are fully converted to alcohols)

Alcohol

- It preserves foods – but doesn't taste that good
- It extracts “active ingredients” from herbs
- It has unique effects on our brains
- Name some products of this type of fermentation:

Alcohol & CO₂ beverages

Beer
Herbal beers
Kombucha
Shrubs
Wine & whiskey (no CO₂)
vodka



Lactic acid – the other product of fermentation

- It preserves our food
- It pickles things
- It is sour but can be made palatable
- Name some products of this type of fermentation:

Fermented milk products

- Cheeses
- yogurt
- kefer

Other Products of fermentation

- Chutney – fermented fruit, now days it’s just sugar preserved fruit or meat without actual fermentation.
- Condiments – ketchup – used to be fermented fish eggs (roe) (British) or ‘kecap’ from Indonesia.
- Sausages: fermented meats (the ‘tang’ in summer sausage)
- Fermented vegetable: soy beans - Soy sauce, Tofu, Tempeh
- Sauerkraut
- Kimichi
- Dilly beans
- pickles

Fermentation vs Pickling

	Fermentation	Canning/Pickling
Preserving Liquid	Brine → Lactic Acid	Vinegar
Environment	Clean	Sterile
Probiotic (alive)	✓ Encourages Good Bacteria	✗ Kills All Pathogens
Adds Nutrients	✓	✗
Speed	Slow	Fast
Flavor	Complex	One-Note
Shelf Stable	✗	✓



a note on canning

- Canning can be accomplished with either fermented foods to lower the pH
- Or
- With commercial vinegar which accomplishes the same thing, but without the bacteria making the acid.

Making Sauer Kraut

- German for Sour Cabbage
- German soldiers were called krauts
- Many variations around the world
- Latin American kraut: add carrots, onion, oregano, pepper flakes.
- Kim-chi. Brine pre-soaked veggy, remove excessive salt, ferment, pepper flakes. A great variety of veggies are used.

Canned sauerkraut

- Shiocton Wis – a cabbage growing area
- Pressure can it with vinegar & heat
- Store it for years.
- Vinegar is not the same as lactic acid for our guts.



TASTE TEST

SUPERMARKET SAUERKRAUT

Fermented sauerkraut

- Pound cabbage to release water from cells.
- This also mixes the natural bacteria found on the outside of a cabbage into the batch.
- Keep the liquid covering the plant material so that you don't grow mold – a sterilized stone or a plastic inner cap will do.
- Give the bacteria in the jar a favorable environment – warmth.

Sauerkraut bacteria

- Early stage:
 - *Enterobacter cloacae* (pronounced Entare O back ter clo A ka)
 - *Erwinia herbicola* (pronounced Er Win E a herb I cola)
- Intermediate stage
 - *Leuconostoc mesenteroides*
(pronounced Luke o nos stock mess entare oye dees)
- Final stage
 - *Lactobacillus plantarum*

Basic Sauer Kraut

- 1 cabbage – shred, cut thin
- 2 T (Tablespoons) salt, not too much or too little
- Pound the shredded cabbage for 10 minutes to release juices
- Put it in a jar
- Get liquid to cover up the cabbage
- Place in a warm room for a 3-day ferment
- Store in a cool, dark place for 3-5 months

Viola, you've made sauerkraut

- Keep the jar in a relatively warm spot at home.
- Allow it to bubble – the bacteria are making CO₂
- After 3 days cap it and store in a cool dark place (or your refrigerator if you don't trust the fermentation).
- Burp the jar occasionally if the fermentation has not slowed.

Kimchi is made in a similar way.

- Cut vegetable pieces small so that acid can get inside.
- Watch the pH to ensure enough acid to pickle the veggies.
- Some veggies do not do well in kimchi.
- Fish sauce and pepper-flakes add spiciness.