NORTHEAST
WI Technical College

Cheesemaking and Fermentation

Lesson 2

Yogurt & Keifer

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Last lessons – key take-home messages

1. Historical context of food preservation. What was the take home message?

- Preservation: processes designed to keep “bad” bacteria from spoiling our food >

  Foods preserved in modern ways are rather dead.

What is preservation by fermentation?

- A process designed to overwhelm “bad” bacteria with good ones > the food is alive.

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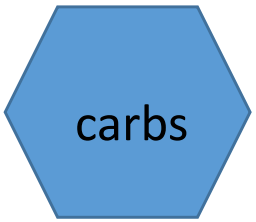
Fermentation – process

- An anaerobic process in which a
- Carbohydrate
- Is turned into
- An (alcohol + CO2) or an acid

- $C_6H_{12}O_6$

CO2 +

ethanol



MICROBES

lactic acid

Temp & Time

PRODUCTS

SUBSTRATE

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Fermentation & cheesemaking

1. What are the microbes ?
2. Which kind of microbes make what kinds of food?
3. Making Kefir, yogurt and sour cream

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Microbes = Yeasts, molds, bacteria

With a partner, make a list of bad/yucky things and good/yummy things bacteria do.

Bad things	Good things

Note to teachers: typically students have an easier time thinking of smelly, yucky gross, disease things bacteria do, rather than 'helpful' things bacteria do.

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Microbes = Yeasts, molds, bacteria

With a partner, make a list of terms you associate with bad/yucky microbes and good/yummy microbes.

Bad & yucky things	Good & yummy things

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Microbes = Yeasts, molds, bacteria

Bad things	Good things
Pus, rot, ooze	Bread, beer, cheese
Spoilage	Preserving
Disease, infection	Antibiotic source
Foreign, invaders	Symbiants, part of us
Dead things	Alive
Fear	Fizzy
pathogen	flora
salmonella	lactobacillus

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Microbes – 3 types we will discuss in class. First up……

- Molds√
- Yeasts
- Bacteria

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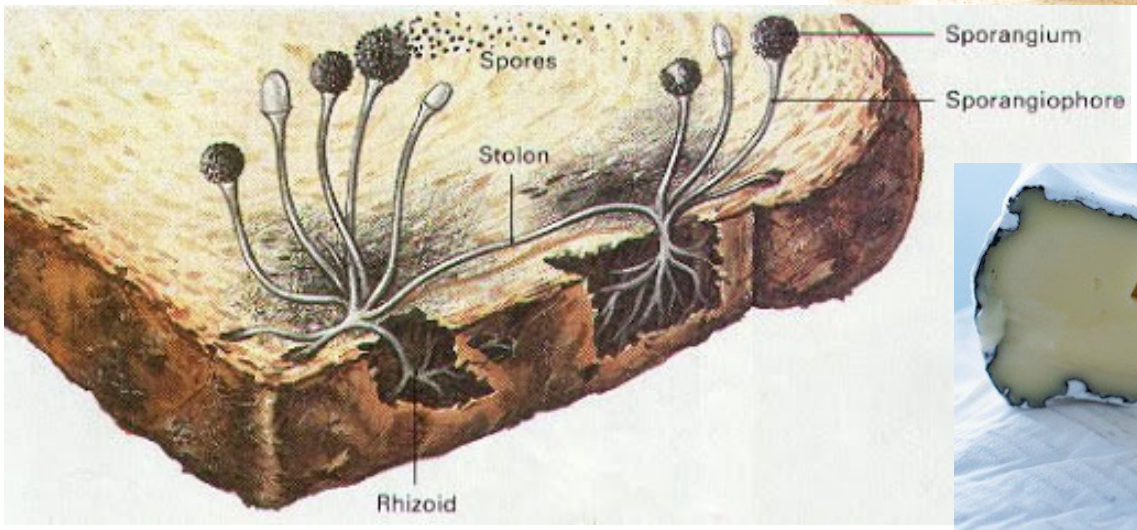
Good mold/ bad mold

- Mold is a type of fungi with a filamentous structure
- Bread molds - spoilage
- Cheese molds – preserve
- Molds do not ferment foods



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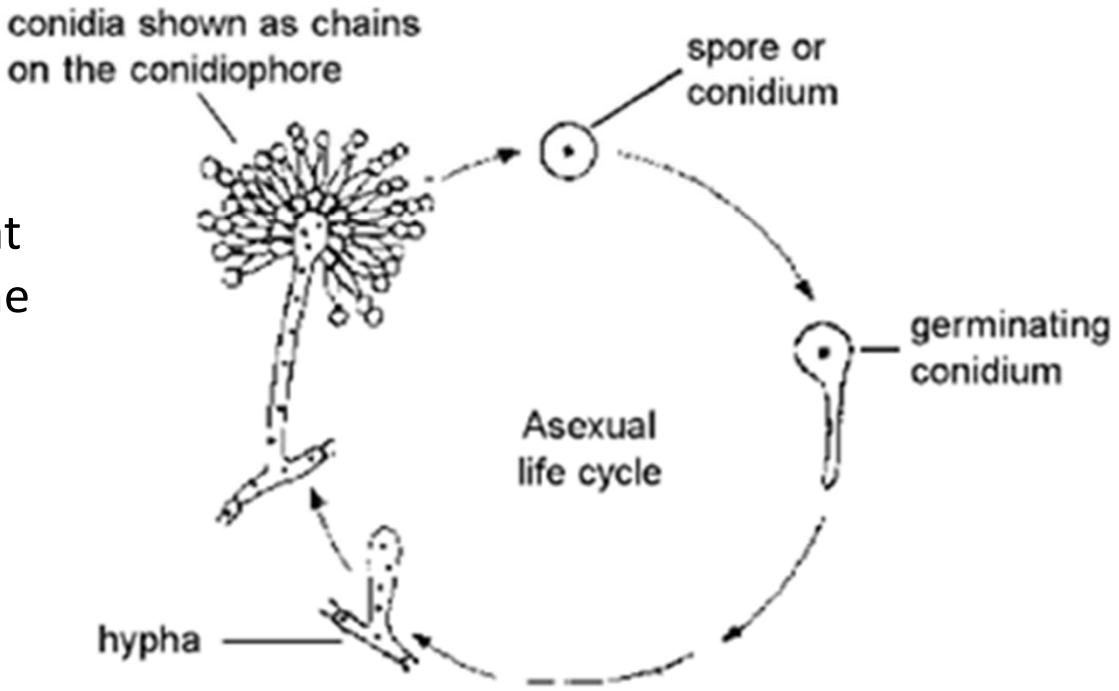
Mold is a fungus

It's the little conidia that glop together to become the 'mold' that we see on bread or cheese



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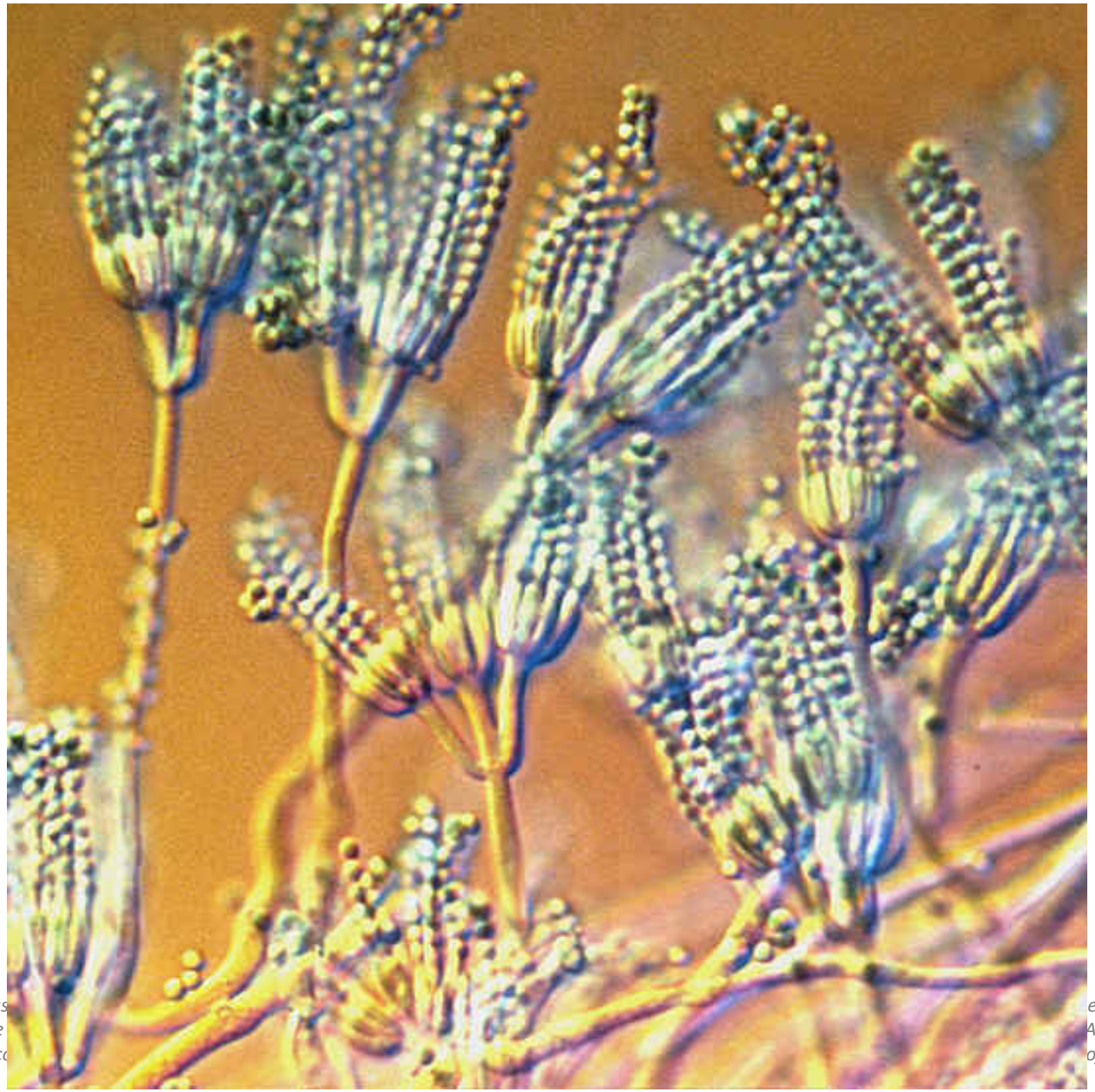
Penicillium Fruiting Body

Conidia close-up



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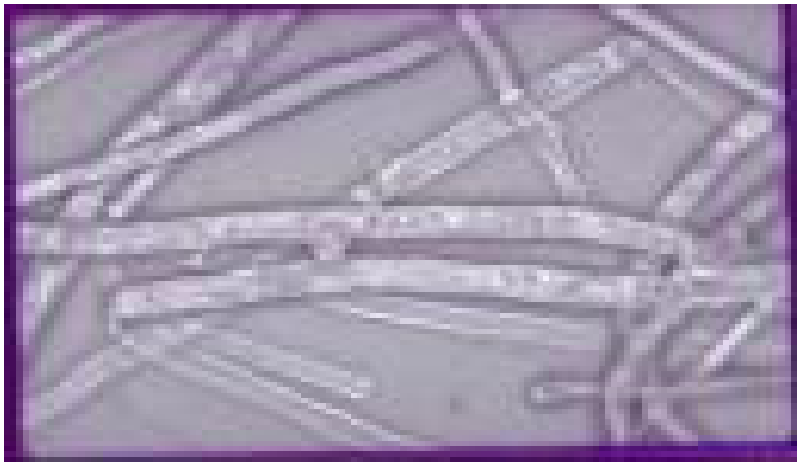
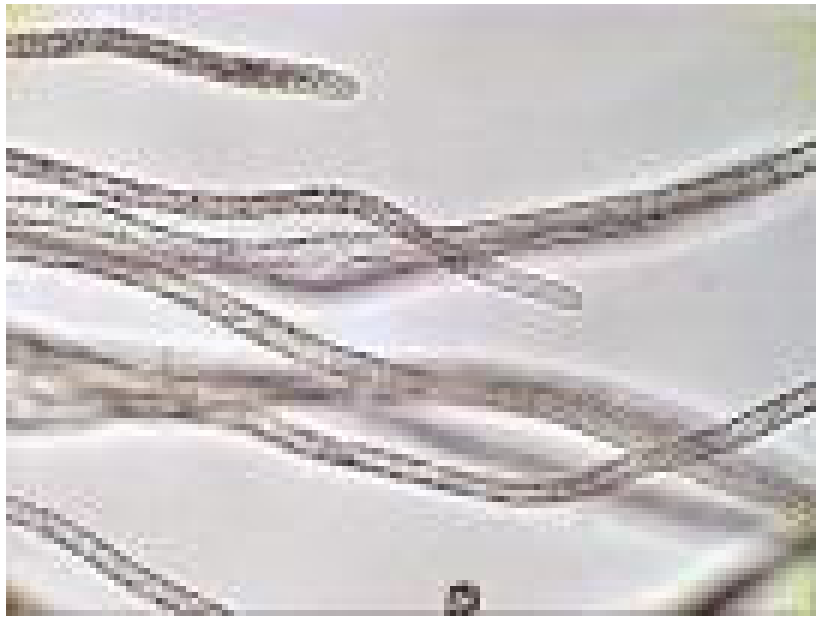
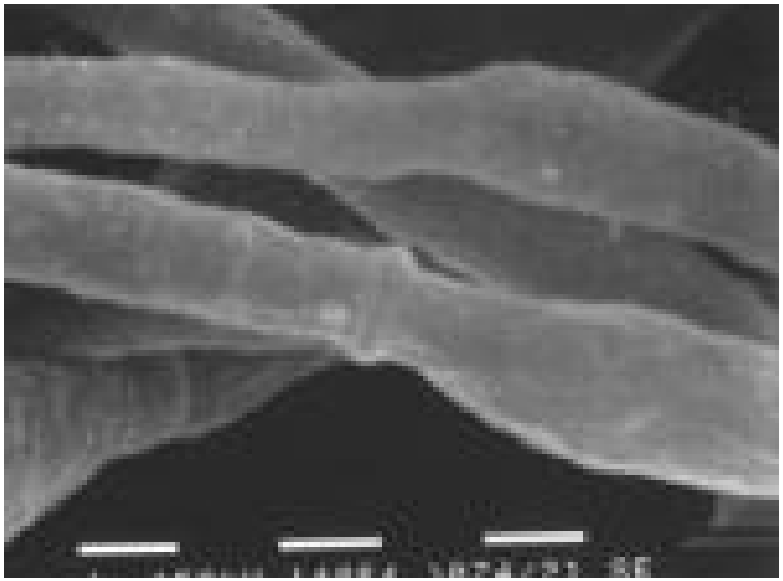
Hyphae – vegetative stage







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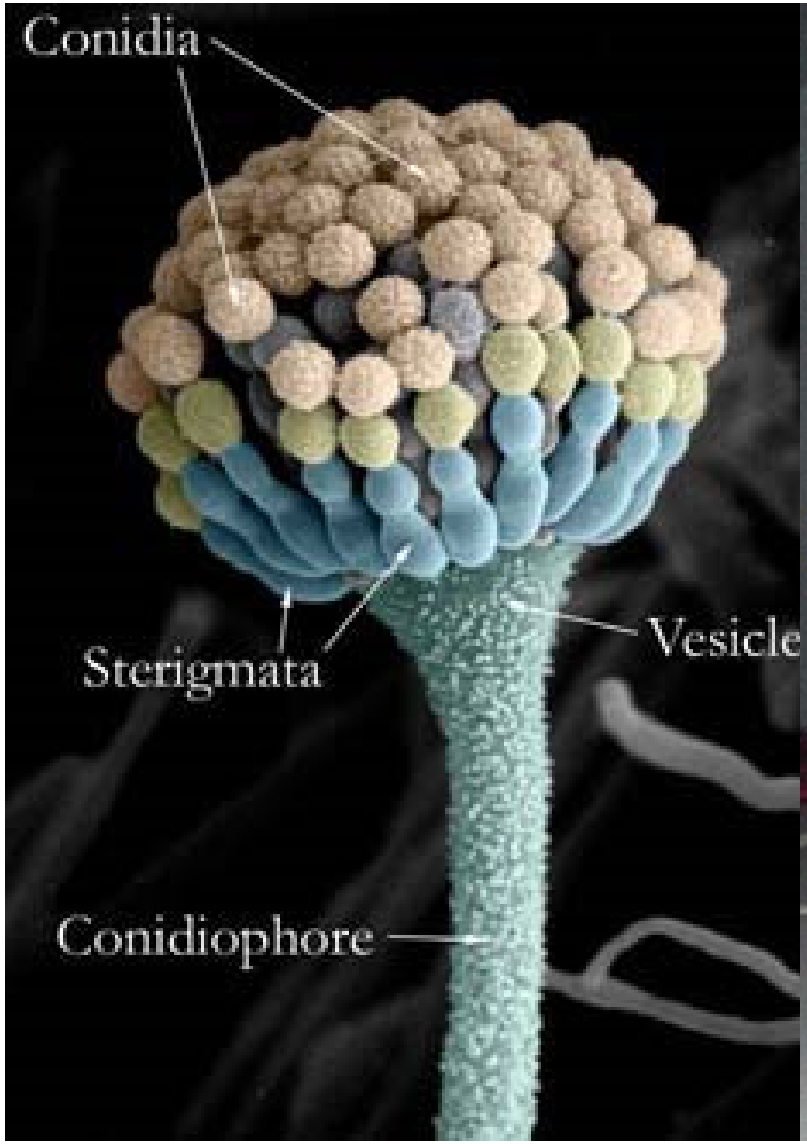
Mold is a fruiting body, just like mushrooms are the fruiting body of a fungus. Some molds we eat, some we don't – they will make us sick



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Yeasts – the second microbe to study for fermentation.

- They are not algae – no photosynthesis
- Not protozoa – they have a rigid cell wall
- Not a bacteria – bigger and eggish-shaped
- They are a loosely defined collection of about 350 species.
- They have no flagella or means of moving
- They live in many places – on us, in soil, in the air, in our foods.

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Yeasts, the good, the bad, the ugly

- Yeast are also technically a type of fungi
- But…..the usual and dominant form is unicellular, not filamentous
- Yeast vegetatively reproduction by “budding”
- Because they are single celled…they grow and reproduce more rapidly than the filamentous molds!
- They also can chemically alter substrates rapidly because of the rapid growth.

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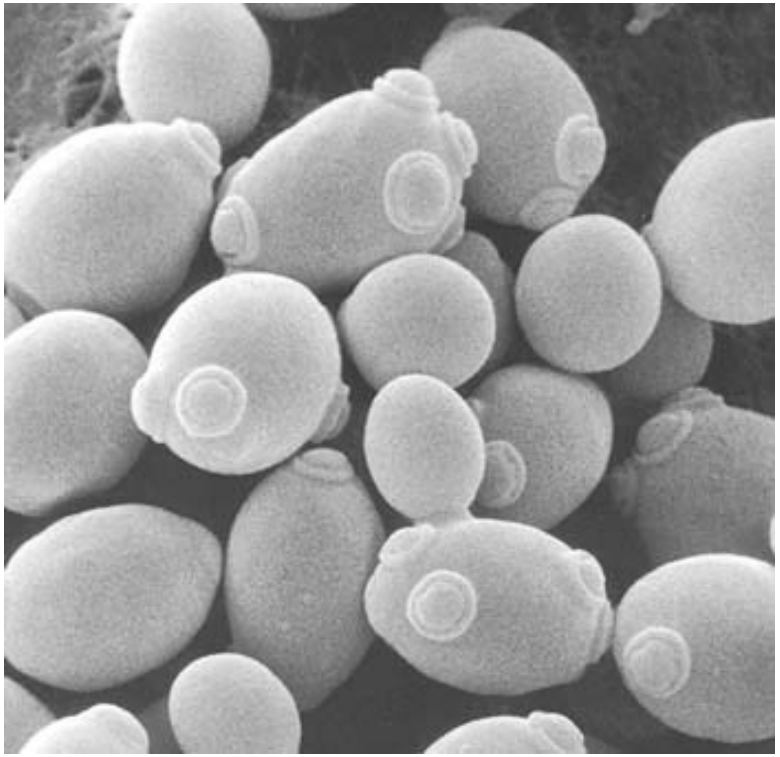
Yeasts bud and reproduce super quickly



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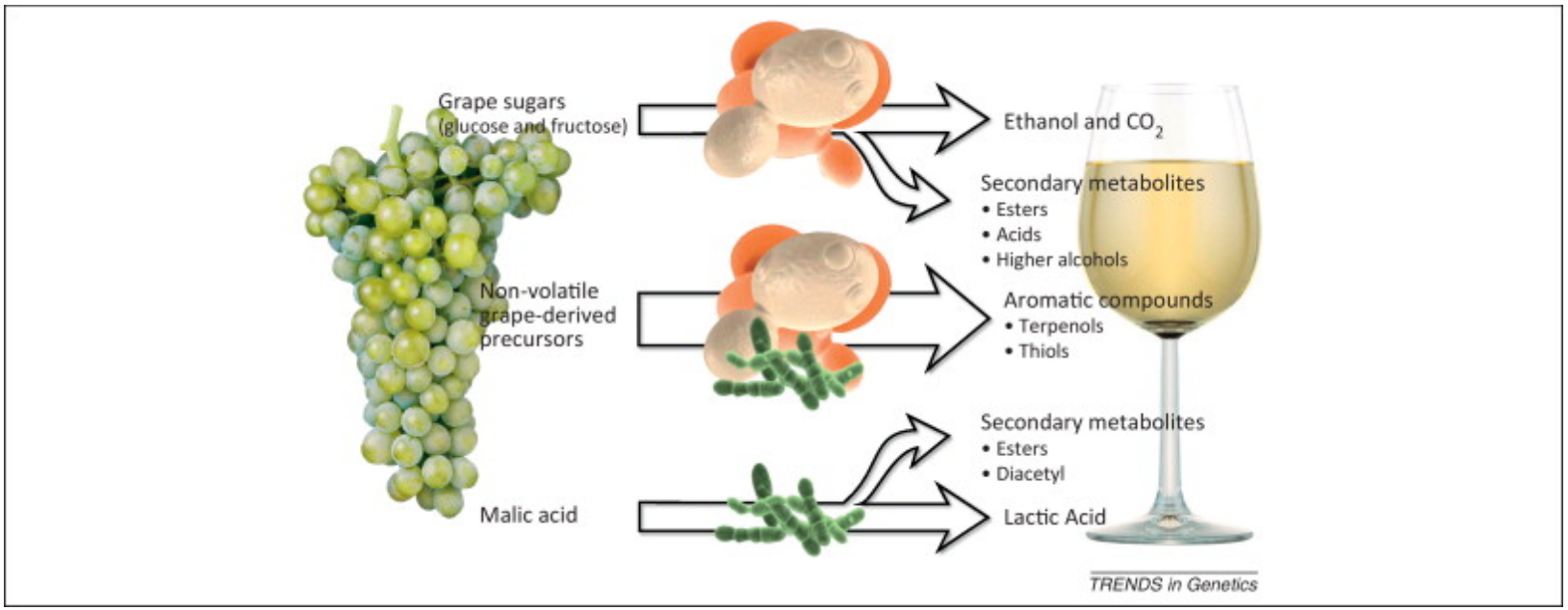
yeasts

- Change glucose to alcohol and CO2 by a variety of alchemy.
- Anaerobic (fermentation) or
- Aerobically (respiration)
- Our most important friend is Saccharomyces cerevisiae.



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Bread yeast

When the substrate (beginning material) is wheat or flour, rather than grapes, the CO_2 the yeast produce make the bread rise and give it an airy texture.

No alcohol is produced.

The yeast species is still S. cerevisiae.

Sourdough bread uses a slightly different yeast species

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Microbes…. our third one is….

- Molds
- Yeasts
- Bacteria√

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Co-evolution

- We co-evolved, we as a species, grew up with bacteria helping us stay alive in winter when all food except meat normally would have been gone. Bacteria (and yeast) preserved our foods and we ate them.

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Bacterial classifications

- How they use oxygen:
  a) Aerobic – needs O2
  b) or anaerobic (clostridia botulinum) – Can't use O2
  c) or facultative anaerobes (e.coli) – can take O2 or leave it
- Shapes:
  a) spheres (cocci),
  b) rod shaped (bacillus),
  c) Spirochetes (corkscrews) usually pathogens (bad guys)
- Temperatures:
  a) Thermophiles (hot)
  b) mesophiles (medium)
  c) Psychrophiles (cold)
- Metabolic types:
  a) Proteolytic (eats proteins)
  b) Lipolytic (eats fats)
  c) Saccharolytic (eats sugars)

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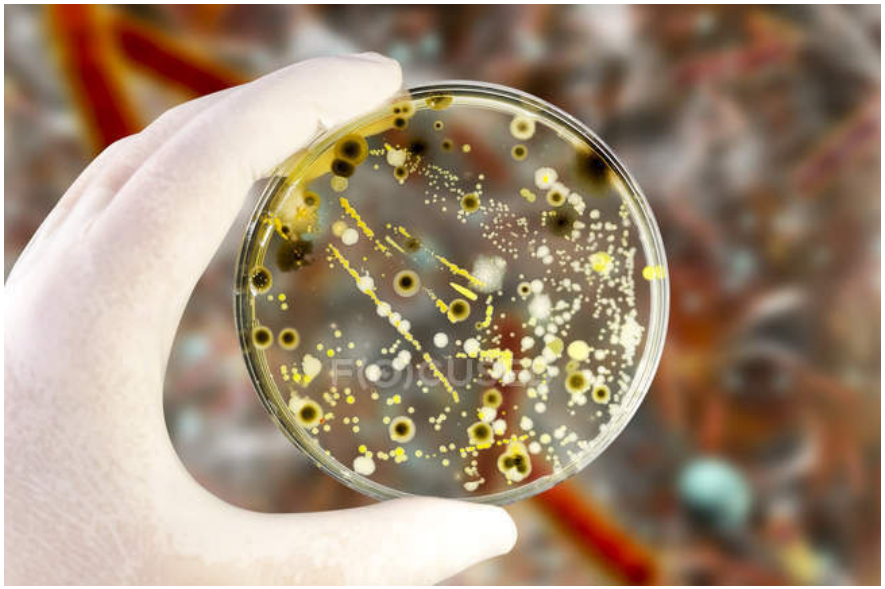
Bacterial cultures

- The bacteria used in food making are referred to as “cultures”.
- Perhaps because calling them ‘colonies’ has connotations of disease
- Interesting that word in English also means groupings or associations of humans and their very positive interactions & outcomes

Culture.

- It is also how we refer to agrarian activity: Agri-culture



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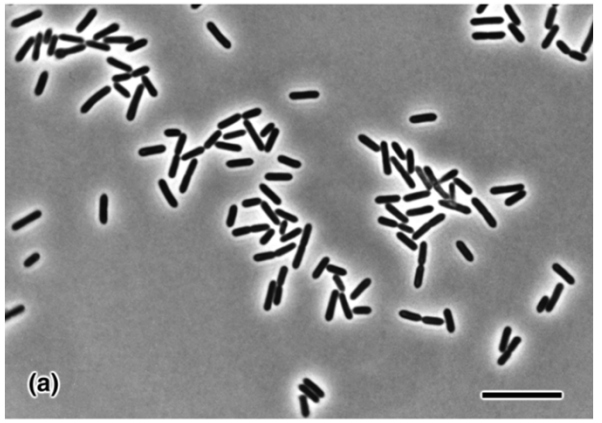
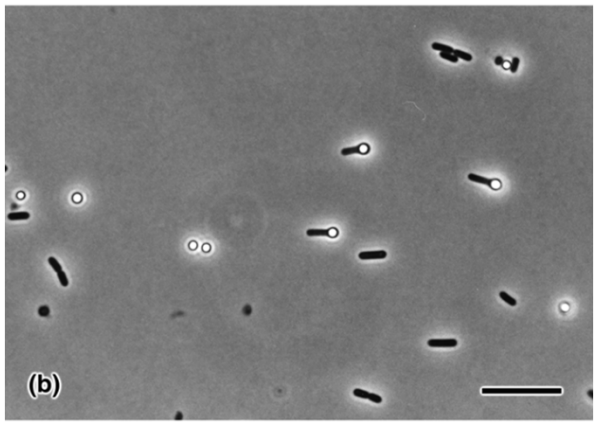
Shapes of bacteria

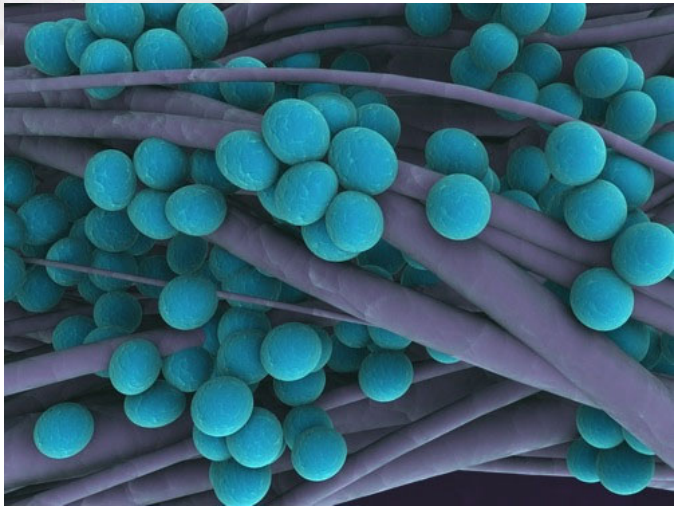
Spirochetes are usually pathogens and cause disease. i.e. Syphilis, Ebola

Bacillus, rod-shaped
These are usually good





Cocci;
Staphylococcus aureus



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Will I get sick from bacteria used in fermentations?

- Fermentation is intrinsically safe.

- *"As far as I know, there has never been a case of food-borne illness from fermented vegetables. 'Risky' is not a word I would use to describe vegetable fermentation. It is one of the oldest and safest technologies we have"*

  -Fred Breidt USDA microbiologist

  (quoted in Katz, The Art of Fermentation)

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Sauerkraut bacteria

- Early stage:
- Enterobacter cloacae
- Erwinia herbicola
- Intermediate stage
- Leuconostoc mesenteroides
- Final stage
- Lactobaciluus plantarum

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Can I get sick from milk fermentations?

- When dealing with milk products, there is the possibility of illness from pathogenic bacterial contaminants of the milk or its products.

- Raw milk is unpasteurized – still has its native bacteria
- Big debates on whether raw milk causes big problems.
- People consumed raw milk ferments for a thousand years before Louis Pasteur ever heated milk to kill bacteria.
- Pregnant or immune compromised people should not consume raw milk.

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When Fermenting milk…..

- The substrate (carbohydrate) is……?
- The bacteria are …….?
- The time and temperature are ……?

- The substrate is Milk
- The bacteria are mostly lacto-bacillus: gram+, non-spore forming. Lysteria is closely related but makes us sick.
- Time and temperature will vary and these variations are what make different cheeses different.

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Simple milk ferments

- Sour cream
- Yogurt
- Kefir

These are very simple and can be done while you are doing other things around the house

They form a very soft ferment of the milk called a clabber

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Clabber

- Old Gaelic word = mud.
- So rarely used it was not in my micro soft dictionary
- It is both a noun & a verb
- Mud is the fats and solids = white
- Whey is the clear-ish, yellow liquid

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How to clabber milk

- Ask very elderly women how they did it and they tell you……
- They just set a bowl of milk on the kitchen counter-top
- Spontaneous fermentation with wild bacteria from the farm
- Temperature dependent
- Results in sour cream – the sour is the lactic acid from the fermentation.

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Sour cream

- Clabber – raw milk, “wild”, good bacteria
- Pasteurized milk does not clabber, it just curdles and spoils

<u>To make your own sour cream…..</u>

Add a bit of store-bought sour cream to raw milk

Or, you can add actual sour cream starter packets like the one shown here.

- Stir in the starter culture
- Incubate at 86 degrees for 24 hours

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Yogurt

- Yogurt making bacteria are thermophilic (they like heat)
- Heat the milk to 180 degrees
- That temperature will kill all bacteria
- Cool the milk
- Add the appropriate bacterial cultures
- Incubate between 110 – 115 degrees
- In class you will learn how to incubate yogurt without a machine

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- Why do we heat the milk to 180 degrees?

- This step kills off the native bacteria that may compete
- It alters structure of the casein (the milk protein)
- The heat evaporation thickens and condenses the milk
- But, it may denature some desirable enzymes

- You do not have to heat the milk to 180. You can make "raw" yogurt but it will not be as thick as commercial yogurt

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- How do we heat the milk? Slowly, so it has some evaporation
- You may use a water bath method or direct heat
- Stir relatively constantly to prevent scalding
- Hold at 180 for 30 seconds
- Commercial yogurts add thickeners now – you could add powdered milk to make extra thick
- Turn off heat

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Cooling the milk

- You can cool the milk passively or actively by putting it in a sink full of cold water. Remove from a cooling bath when temp drops to 120. Don't over-cool it.
- When the milk cools to 110-115 degrees add your starter powder.
- Before adding powder, stir in or remove any skim that may have formed
- If the milk is too hot it will kill the bacteria that you add.

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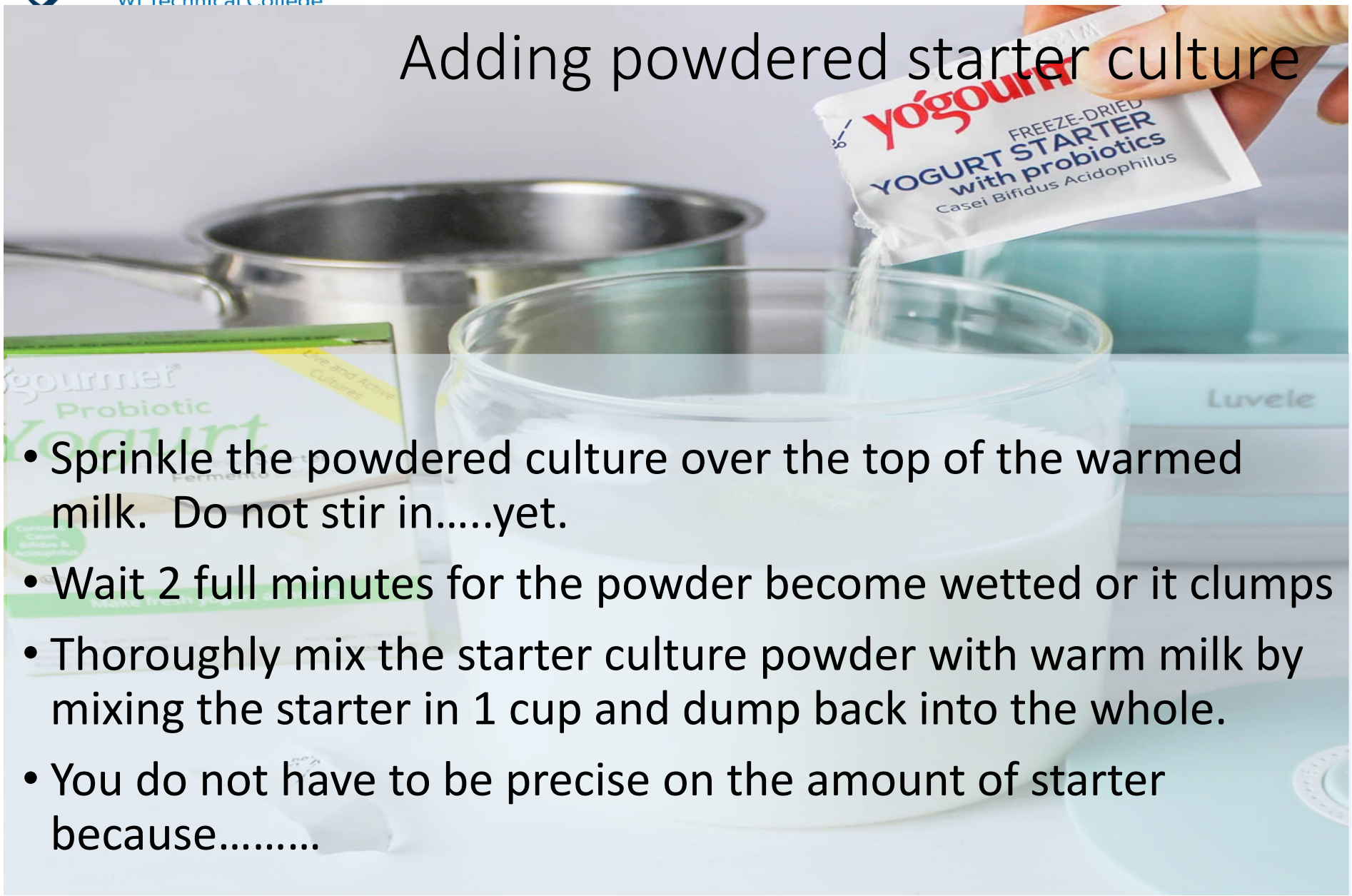
Adding powdered starter culture



- Sprinkle the powdered culture over the top of the warmed milk. Do not stir in…..yet.
- Wait 2 full minutes for the powder become wetted or it clumps
- Thoroughly mix the starter culture powder with warm milk by mixing the starter in 1 cup and dump back into the whole.
- You do not have to be precise on the amount of starter because……

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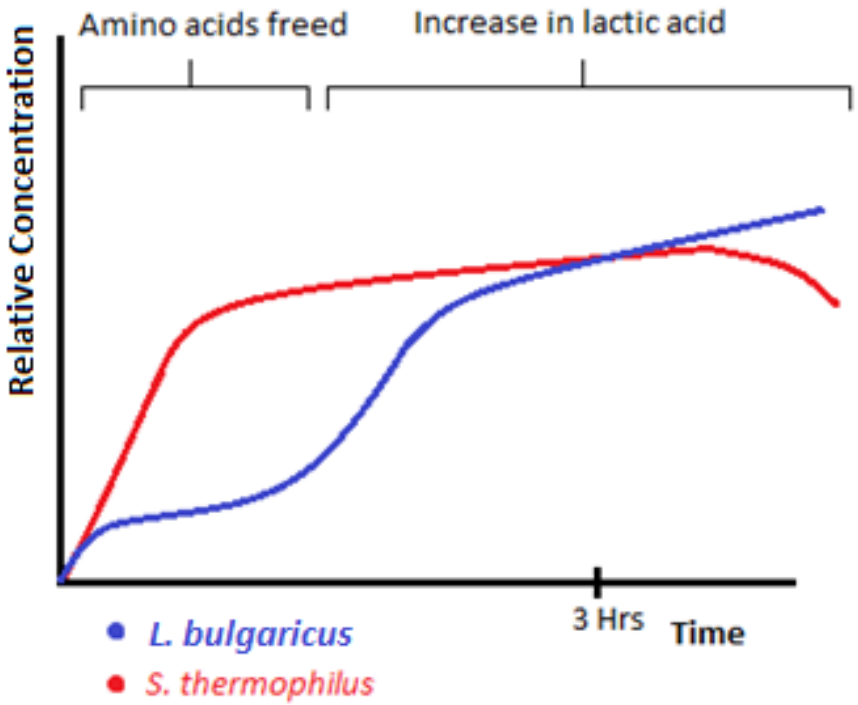
The bacterial population grows



Lactobacillus bulgaricus and *Streptococcus thermophilus*

- The bacteria in the starter culture reproduce and multiple and will grow a population to a huge size in a short time.
- They will produce lactic acid.
- The acid environment stops growth of bad bacteria
- The substrate (milk sugar, lactose) is converted (lactate) at a certain point and growth stops
- The protein in the milk falls out of solution as a soft curd as the milk becomes more acidic

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Incubation is fermentation

- To foster ideal growth for these lactic acid bacteria:
- A balmy 110-115 degrees is ideal.
- Milk should ferment/coagulate in about 3-6 hours.
- The longer you ferment it, the tangier it gets because more acid is produced.

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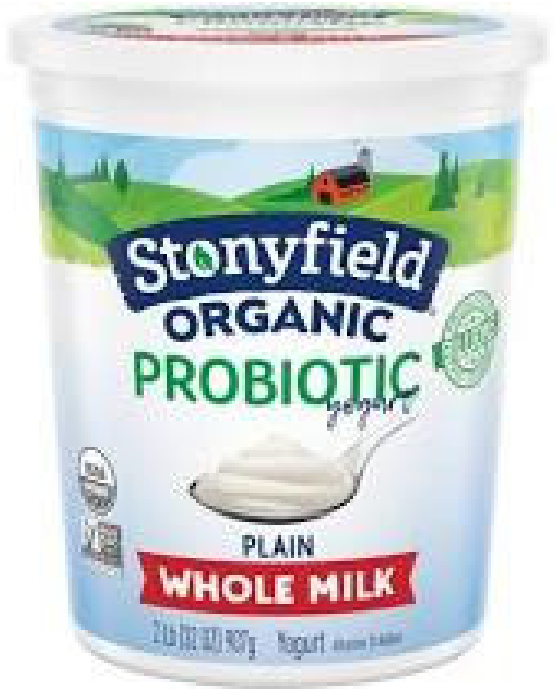
Adding starter cultures – store bought

- If using store-bought yogurt as a starter then make sure it has warmed up to room temp.
- If using store-bought yogurt add ¼ cup of starter culture to 1 quart of milk.
- Try to use plain, not flavored yogurts
- Look for the words ‘live active culture’ on the container



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How do I hold 110-115 degrees for 5 hours?

- Make an incubation chamber.
- Yogurt bacteria do not need oxygen so don't worry about air flow
- Pour your warm/cultured milk into a thermos.
- Put filled jars in a "reverse cooler" with warm water. Be sure to pre-heat these items first.
- Use a light bulb over a box
- Use your oven, pre-heated turned off, with the door slightly open so the light bulb is on.
- Use a hot water bottle or a heating pad. Be creative.
- Try a dehydrator on a low setting?

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Hold at 110-115 degrees

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Greek or regular yogurt

- Greek has a lot less sugar
- Greek is higher protein yogurt
- Greek has more S. bulgarii bacteria
- Look for the types of starter bacteria listed in the ingredients list.

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Kefir

- What is it?
- A milk ferment. A beverage.
- Bubbly – CO2 due to the presence of yeast
- The Champagne of milk.
- Alcohol content = almost none to 3%
- SCOBY – a mat of symbiotic microbes which is macroscopic (like kambucha)

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Kefir grains

- A community of about 30 different microbes
- Lacotbacilli, leuconostoc, acetobacter, saccharomyces (yeast)
- Only ½ the microbes are known or named yet people have been drinking this stuff for thousands of years – and not dying.
- They create a new “being” that is little understood and can perhaps “live forever”.
- You can use dry powdered bacterial starter culture as well

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Kefir – so easy to make!

- Warm milk to room temperature
- Add the grains
- About a heaping teaspoon per quart of milk
- Do not fill up your container
- Leave room for CO2
- Seal it (pressure will build) and make a bubblier drink
- ……. or put lid on loosely.
- Leave it to ferment at room temp.
- No direct sunlight
- Gentle shake occasionally to agitate the grains
- Ready in about 24 hours, longer in a cool room

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Perpetuating your kefir

- Shake your jar a little
- Fish the grains out with a spoon
- Or strain thru a strainer
- Put grains in a clean jar
- Pour new, fresh milk over them
- Get into a rhythm
- Think of this as a pet that needs care and feeding – ongoing, but not constant care
- The grains double every week to ten days
- You can rinse, dry and store. Or freeze to store.

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Type of milk for kefir

Personal preference:

- Raw, whole, pasteurized, skim, even ultra-pasteurized.

- Glass is preferred to any contact with steel by most kefir farmers

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Summary of instructions

Creamy yogurt Y3	Sweet yogurt Y5	Sour cream	keifer
S. thermophilus L. delbrueckii spp. bulgaricus	S. thermophilus L. delbrueckii spp. bulgaricus LA Acidophilus L. lactis, Bifido	S. lactis S. cremoris L.B. diatylactis M.S. cremoris	Lactic bacteria yeasts
Heat milk to 180-185 then	Heat milk to 180-185 then	Heat milk to 86	Heat milk to 86
cool to 112 before adding starter culture	cool to 112 before adding starter culture	Add starter culture	Add starter culture
Incubate at 110-112 6-12 hours	Incubate at 110-112 6-12 hours	Incubate at warmish room temp for 12-24 hours	Incubate at warmish room temp 12 hours
Store in fridge	Store in fridge	Store in fridge	Store in fridge

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