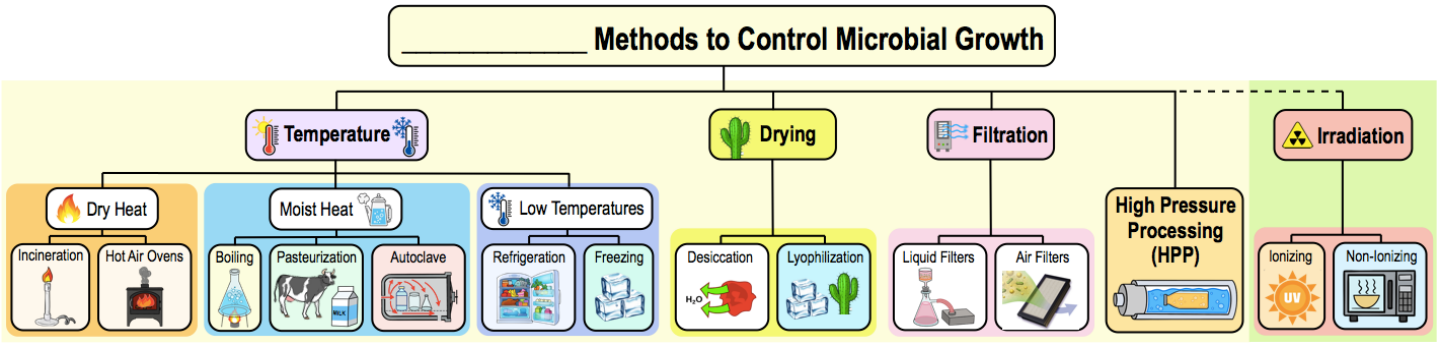
CONCEPT: PHYSICAL METHODS TO CONTROL MICROBIAL GROWTH

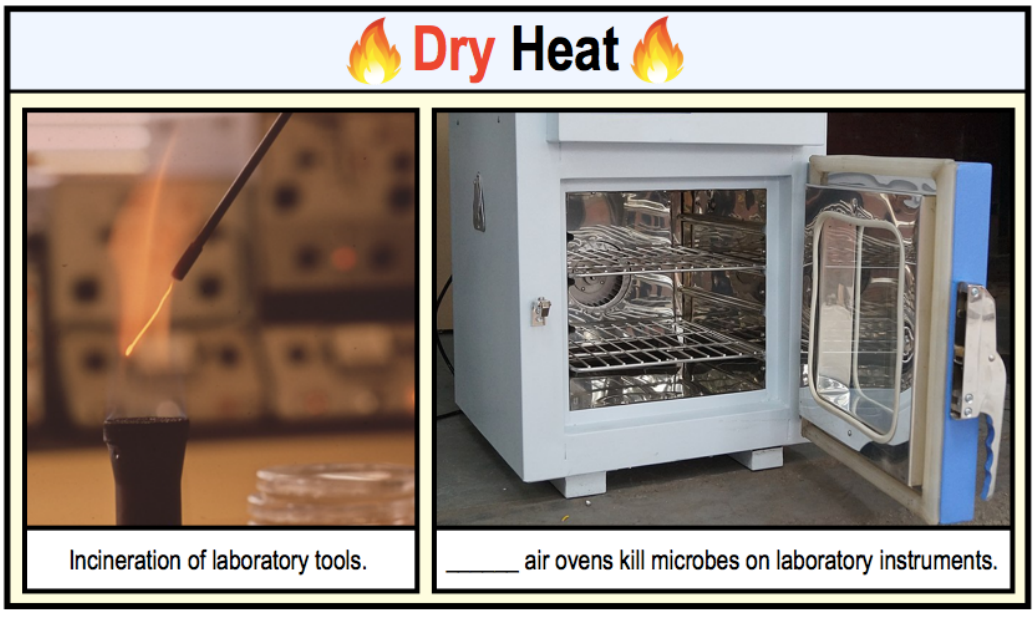
●Physical methods of controlling microbial growth include:



Dry Heat

●**Dry Heat**: heat that has _____ moisture or liquid content.

- □ **Incineration**: destruction by _____ with a flame, turning cell components to ashes.
- □ **Hot Air Ovens**: ovens that kill microbes with dry heat by destroying cell components & denaturing proteins.
  - □ Requires _____ temperature & _____ time to kill microbes than moist heat.
  - □ Advantage is that dry heat can be used on some moisture-sensitive items (ex. powder & oils).



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Moist Heat

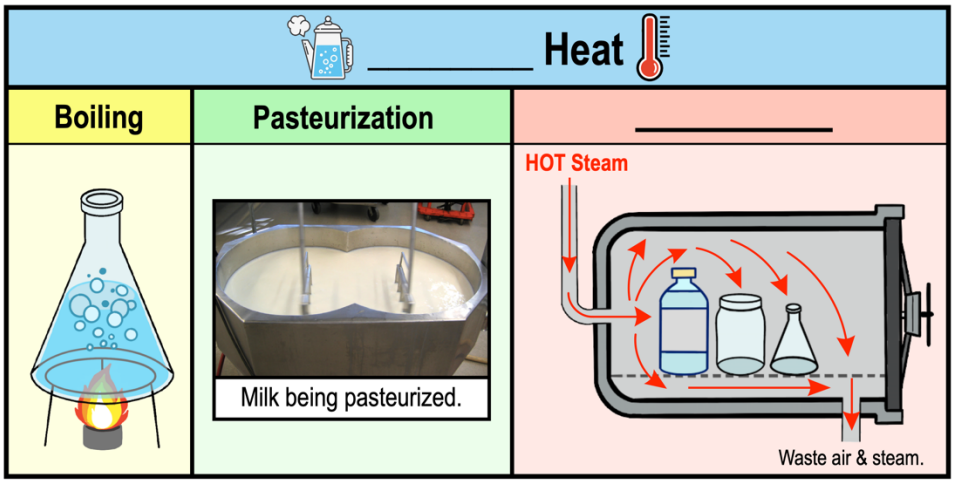
●Most microbes require specific temperatures for normal growth/reproduction; exceeding those temps destroys microbes.

●**Moist Heat**: heat that has _____ or liquid content.

- □ Can kill microorganisms by irreversibly _____ their enzymes/proteins.
- □ Moist heat generally requires _____ temperature & _____ time to kill microbes than dry heat.

●Examples of moist heat include _____, **pasteurization** (*brief heat treatment*), & **pressurized steam**.

- □ **Autoclave**: device using high temperatures & pressurized steam to *sterilize* heat-&-moisture-tolerant items.



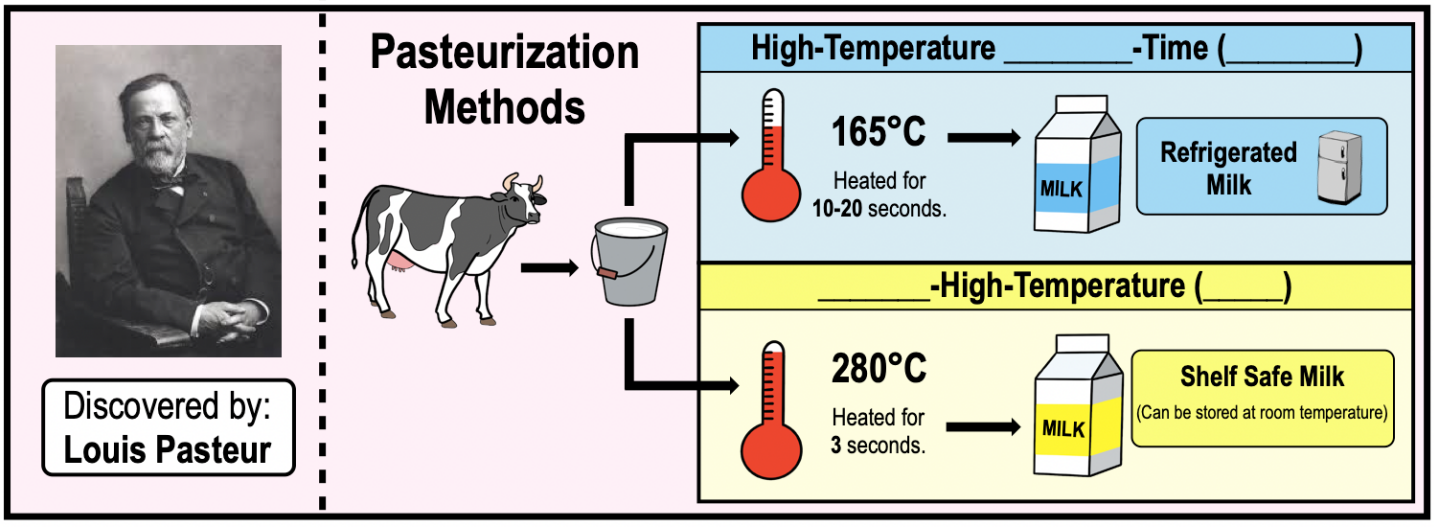
Type of Heat	Temperature	Time to Sterilize
_____ Heat	121°C	600 mins (10 hours)
Moist Heat	121°C	15 mins

Moist Heat: Pasteurization

●**Pasteurization**: *brief* _____ of a product (ex. milk or wine) to disinfect it & make it safe for consumption.

- □ Most pasteurization is by the _____-**Temperature**-_____-**Time** (**HTST**) method (ex. 165˚C for 15sec).
- □ *Higher* temperatures used in the _____-**High-Temperature** (**UHT**) method to *sterilize* (ex. 280˚C for 3 sec).

EXAMPLE: HTST vs. UHT Pasteurization Methods.



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PRACTICE: Pasteurization is what type of microbial control method?

a) A physical, dry heat control method.

b) A chemical, heat control method.

c) A physical, moist heat control method.

Low Temperatures

●Depending on the type of microbe, _____ temperatures can have varying effects, but generally _____ growth.

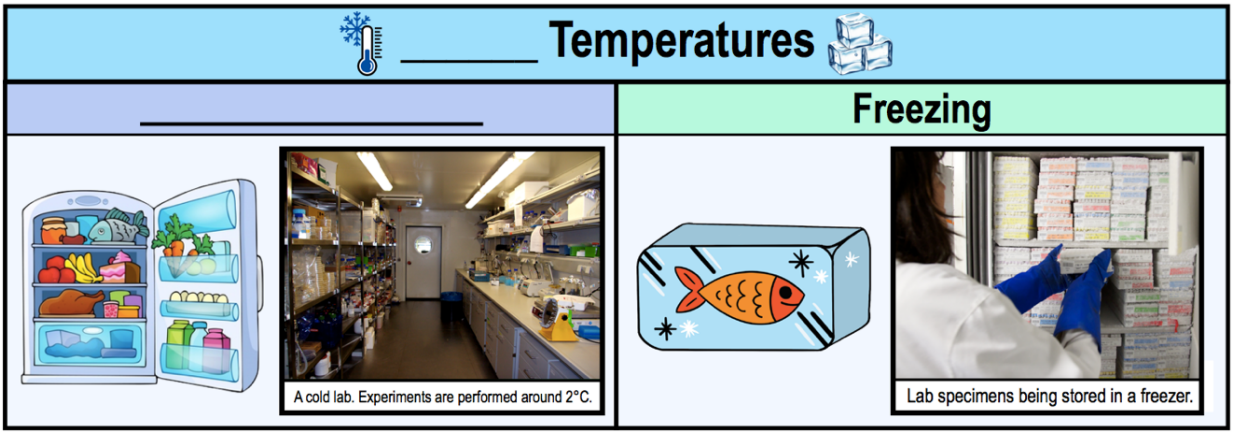
□ Recall: Psyhcrophiles & psychrotrophs are *exceptions* that can grow at freezing temperatures below 0˚C.

●*Refrigeration* generally _____ or *slows* growth of many pathogens & spoilage microbes.

□ *Freezing* usually preserves foods & other products by _____ microbial growth, but it doesn't always kill.

□ Recall: **Preservation**: process of *delaying* spoilage of *perishable products* (items likely to go bad quickly).

EXAMPLE: Refrigeration & Freezing can Control Microbial Growth.



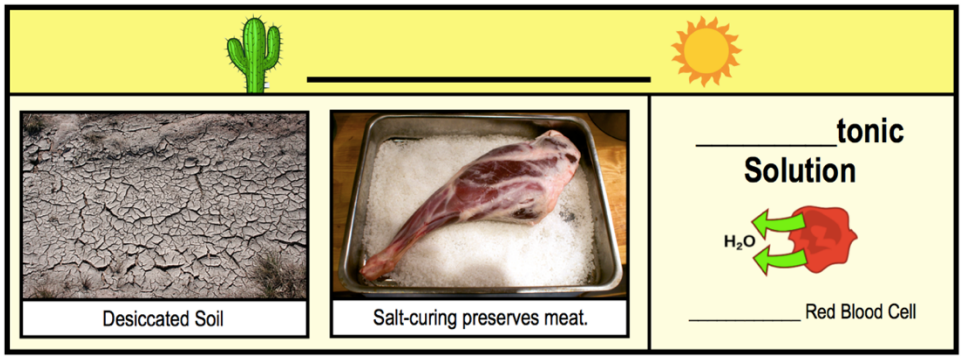
Desiccation

●Although some microbes can survive for years without water, most microbes require _____ to grow effectively.

●**Desiccation**: process of _____ out or *removing* moisture/water from something.

□ Generally, results in the _____ of microbial growth.

□ Addition of solutes (ex. salt) creates a _____*tonic* environment to draw water out of cells & dehydrate them.



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PRACTICE: How does desiccation control microbial growth?

a) Desiccation removes all moisture from living cells, inhibiting or killing microbes.

b) Desiccation drops the temperature so low, that only psychrophiles can survive.

c) Desiccation utilizes ultra-heated steam to kill pathogenic microbes.

d) Desiccation incinerates all living cells, killing all microbes.

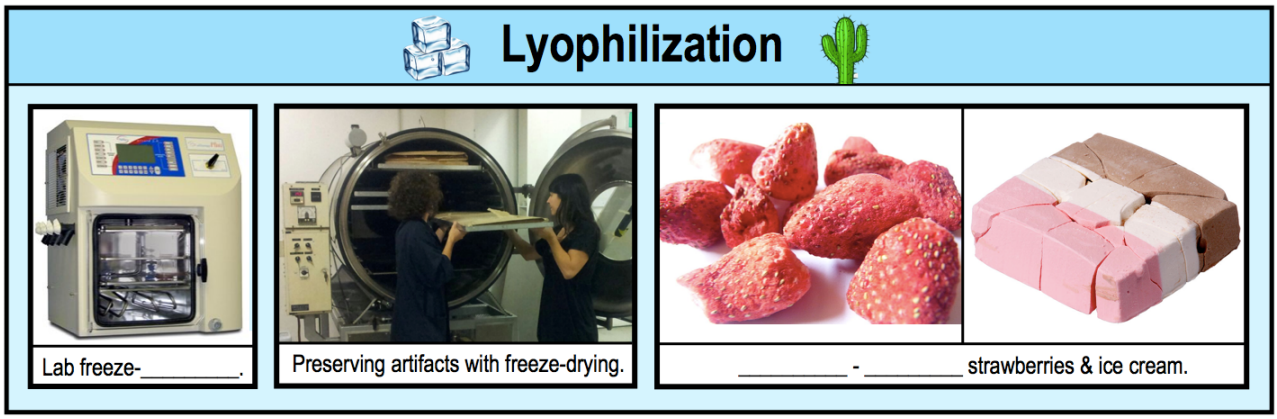
Lyophilization

●**Lyophilization**: the process of _____-_____ (*freezing* the product and then *drying* it in a vacuum).

□ Removes H_2O via **sublimation** (transition of H_2O directly from a solid to a gas state, without becoming liquid).

□ Widely used for _____ foods (ex. coffee, milk, meats, vegetables) without refrigeration.

□ Overall quality of the product is usually better than using typical drying methods.



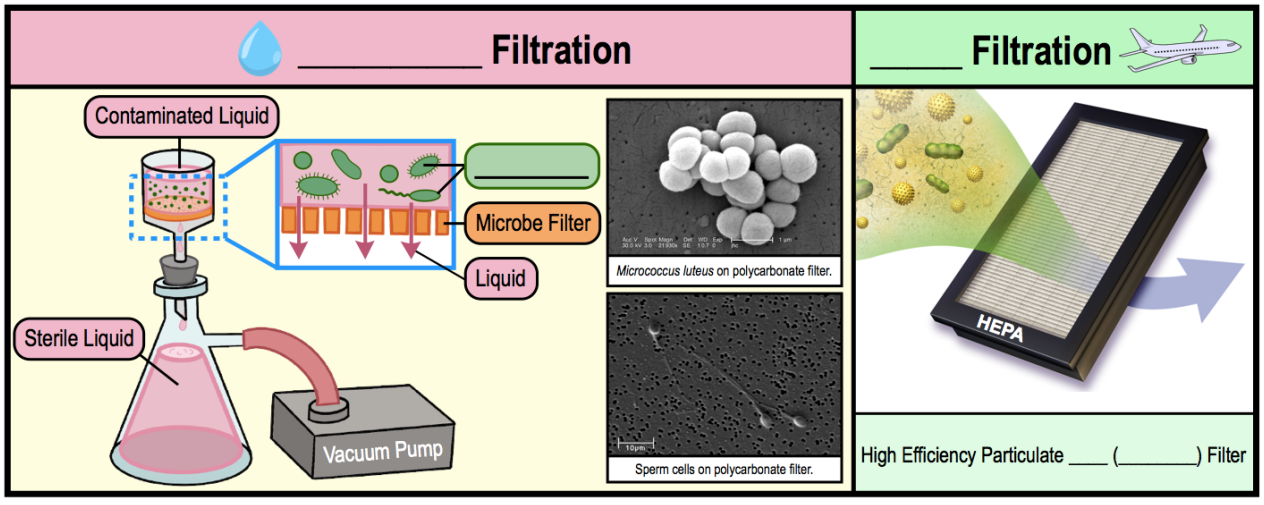
Filtration

●**Filtration**: process of using filters with pores small enough to physically _____ microbes from liquids or air.

□ Microbes are too _____ to pass through pores of the filter & get trapped, separating them from the liquid/air.

□ Can be used to remove microbes from heat-sensitive fluids.

□ **High-Efficiency Particulate Air** (_____) **Filter**: removes airborne particles & microbes from the air.



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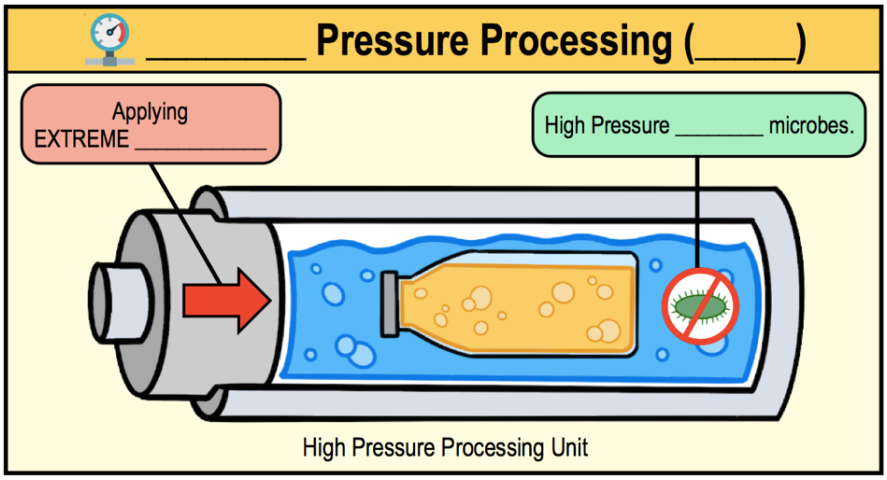
High Pressure Processing

●**High Pressure Processing** (_____): process using high _____ (~120,000 psi) to destroy microbes.

- □ Can alter molecular structures of _____ to kill microbes.
- □ Can _____ products while preserving features like flavors, colors & nutrient values.
- □ Some microbes (ex. endospores) can tolerate high pressures, so it does _____ always *sterilize*.



Irradiation

●**Irradiation**, the process by which an object is exposed to _____; can be used to destroy microbes.

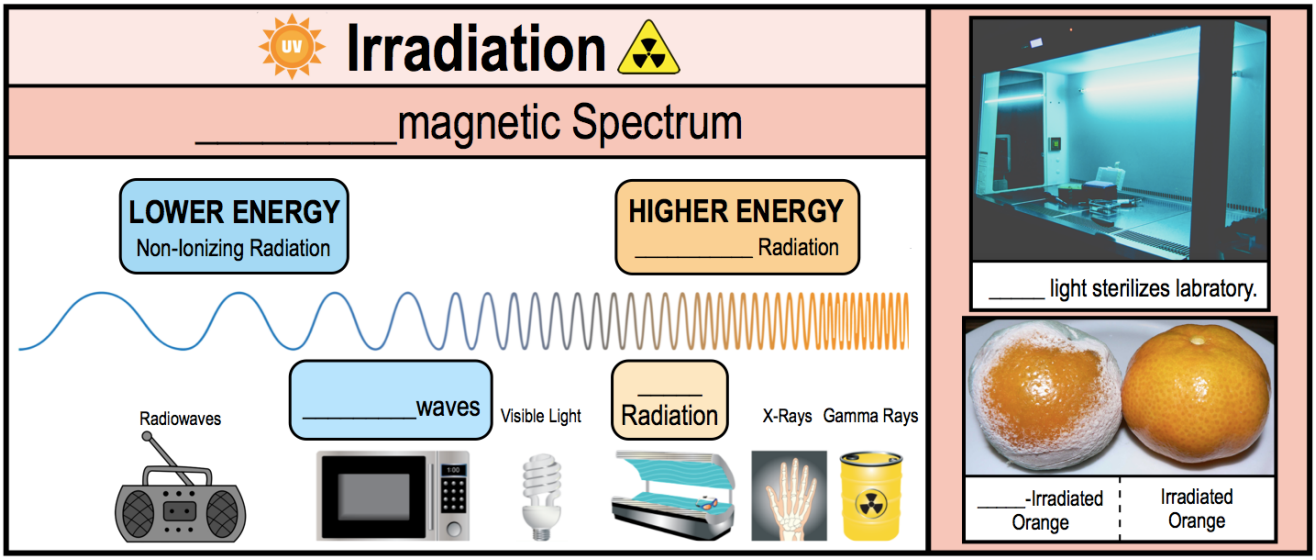
- □ **Radiation**: emission or transmission of energy as *electromagnetic* _____ or moving *subatomic particles*.

●**Ionizing Radiation**: *penetrative* radiation with sufficient energy to remove electrons & _____ atom/molecules.

- □ Harms cells by destroying DNA, membranes, & creating **Reactive Oxygen Species** (_____).

●_____**-Ionizing Radiation** is _____ penetrative & has _____ energy, so must be used directly on microbes.

- □ *Ultraviolet (_____) light* damages DNA & proteins in the cell.
- □ *Microwaves* can generate lethal amounts of _____.



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PRACTICE: This method of physical microbial control combines the removal of all moisture with extremely low temperatures.

a) Desiccation.
b) Lyophilization.
c) Irradiation.
d) Pasteurization.

PRACTICE: How does irradiation control microbial growth?

a) Some types of radiation can create lethal amounts of heat.
b) Radiation penetrates cells causing damage to DNA and cell membranes.
c) Radiation creates reactive oxygen species which damage cellular processes.
d) All of the above are ways that irradiation controls microbial growth.

PRACTICE: A heat-sensitive liquid in a laboratory has been contaminated with *E. coli* bacteria. Which form(s) of microbial growth control could you use to remove this *E. coli* population from the liquid?

a) Desiccating the liquid.
b) Freezing the liquid.
c) Filtering the liquid.
d) Boiling the liquid.

PRACTICE: How does high pressure processing (HPP) control microbial populations?

a) Extreme pressure damages the proteins within microbes until they can no longer function.
b) Extreme pressure destroys DNA and membranes within microbes.
c) Extreme pressure removes water from microbial cells via sublimation.
d) Extreme pressure combines with extreme heat to pasteurize the product and kill microbes.