THE UNIVERSITY OF MELBOURNE

FOOD20006

Food Microbiology & Safety

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Extrinsic factors

Reading: Ray and Bhunia Chapter 6 and 37

Intended learning outcomes

Explain what are the extrinsic factors that affect the growth of microorganisms in food

Relate the extrinsic factors to the control of microorganism in food

MICROBES

Metabolic capacity

optimal growth preferences

Ability to compete with other microbes

Implicit factors

Growth rate

Sensitivity to physical and chemical damage

Factors affecting microbial growth and survival in food

FOOD

pH and buffering

Redox potential

Extrinsic factors

Intrinsic factors

humidity

temperature

Antimicrobial fa

Gaseous atmosphere

Water activity

Nutrient content

Extrinsic factors: humidity

The humidity of the atmosphere around a food will result form the interplay between the water activity of the food

An equilibrium is achieved in a closed vessel. E.g. biscuits in a sealed container stay crisp (low Aw) but if left in the humid air they absorb water and become soft.

There are a number of ways we can manipulate the humidity to maintain Aw (either keep foods moist or dry)

Factors influencing microbial growth in food

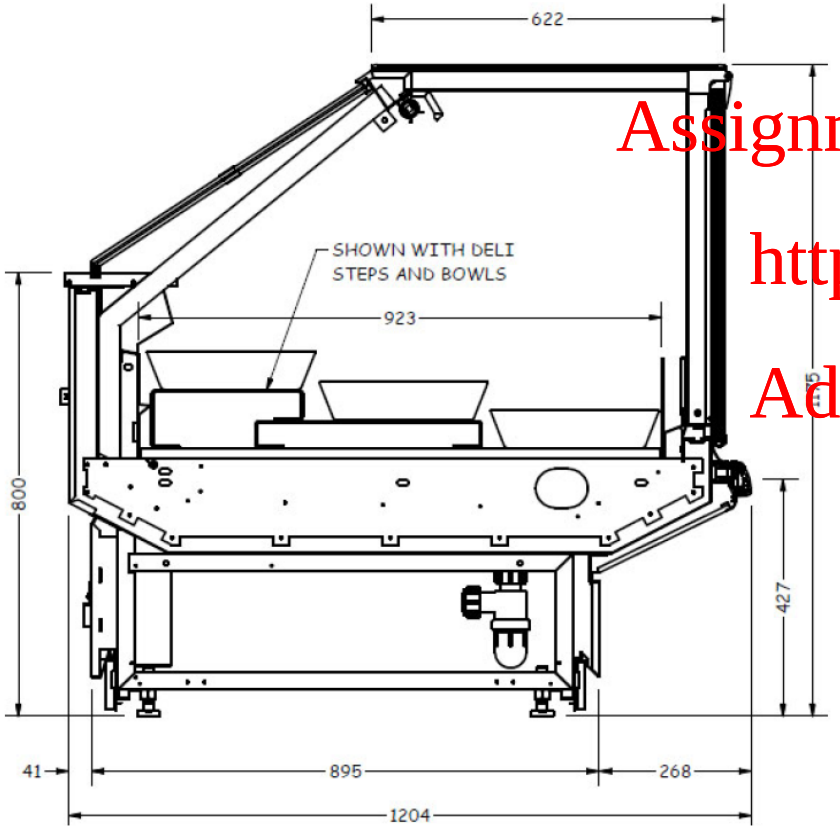
intrinsic factors = factors in the food

Extrinsic factors= environmental factors

Compare the extrinsic factors affecting the salamis hanging in the background and the fresh meats in the chiller cabinet

https://www.mcalpinehussmann.co.nz/

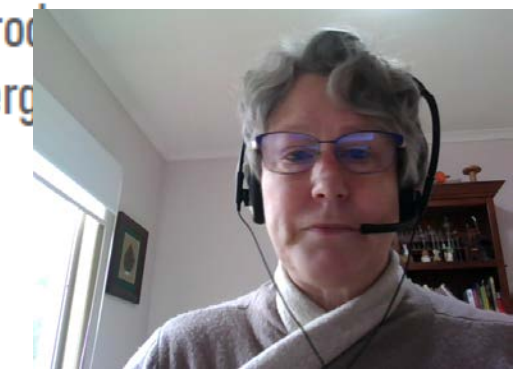
Deli display cabinet - example



Features

This 3rd generation ID3BL-D is a forced draft refrigerated display cabinet. Cooling is from low velocity forced draft air. This provides gentle cooling with low dehydration levels, resulting in longer product life.

The deck is angled for improved for improved display and easier serving, and the cabinet features double glazed lift front glass. LED lights provided enhanced prod illumination and longer lamp life with lower energ



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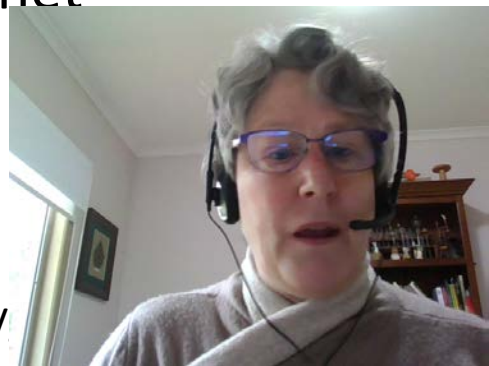


Extrinsic factors: Temperature

- Cell growth is dependent on chemical reactions
- Temperature directly affects the rates of chemical rx.

~ 10°C rise, will double a reaction rate

~ 10°C fall, will half the reaction rate

This changes outside the growth range (no growth)

Foods:

- storage of foods – usually cold, -20°C to 5°C
- Some are stable at ambient temp. (10-35°C)
- Ready-to-Eat (hot) – usually 50-60°C

Extrinsic factors: Temperature

Three main 'temperature groups' of microbes

1. Thermophiles
   – high temp: opt ~ 55°C (range 45-70°C)

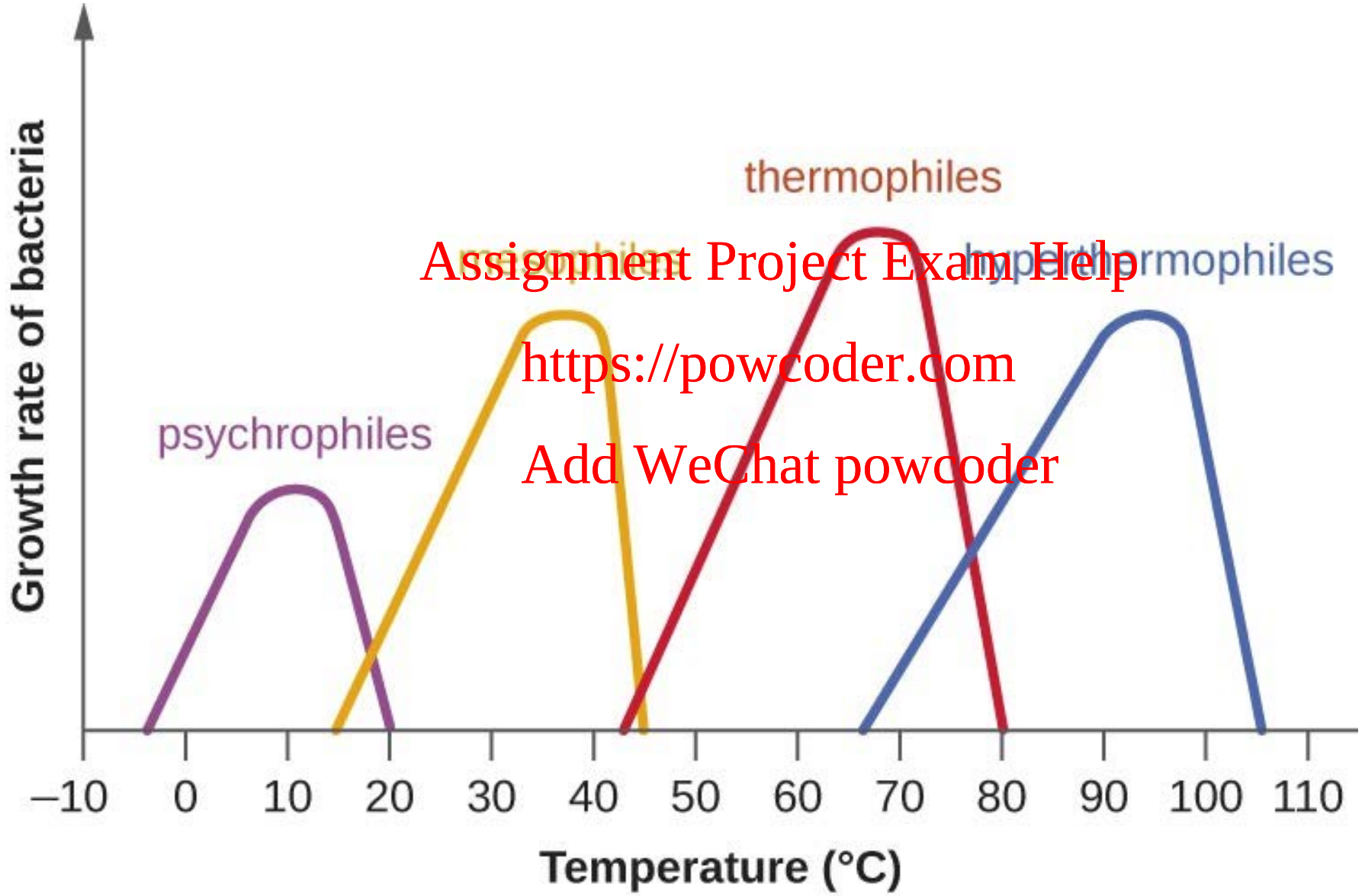
2. Mesophiles – opt ~ 35°C (range 10-45°C)

3. Psychrophiles – opt ~15°C (range -5 to +20°C)

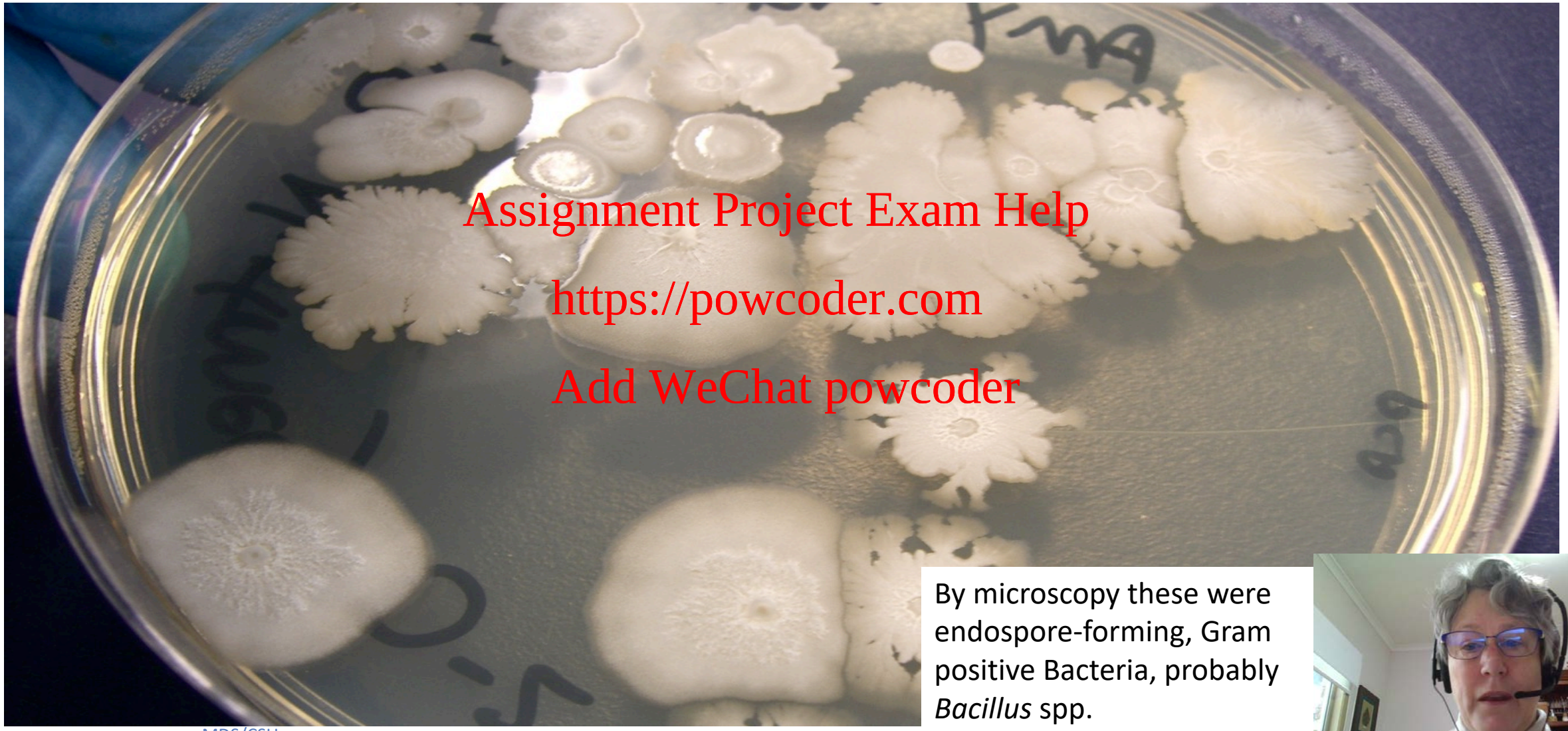
Two more groups are also important in food microbiology:
These properties are implicit factors of the microbes

Psychrotroph – can grow at refrigerator temperature (0-5°C) regardless of their optimum growth temperature.

Thermoduric – can survive pasteurization heat treatments.



Thermoduric bacteria (from pasteurized milk)



By microscopy these were endospore-forming, Gram positive Bacteria, probably *Bacillus* spp.

Extrinsic factors: Gaseous atmosphere

Remember that different microbes have different requirements for oxygen

Aerobes

Facultative anaerobes

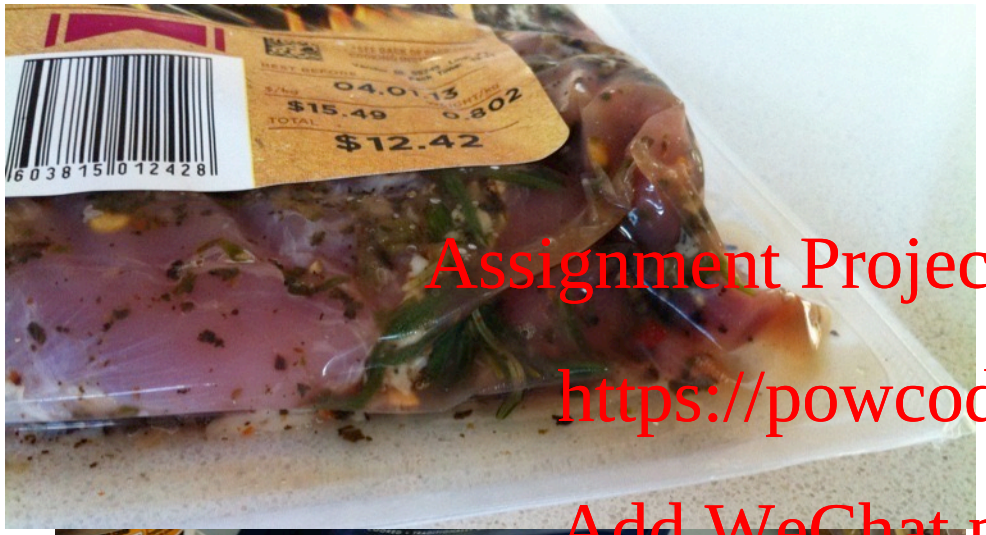
Anaerobes

Microaerophiles

The gaseous atmosphere around a food will influence which microbes can grow

In food packaging we can manipulate the atmosphere by adding different gas mixtures such as CO_2, N_2

Modification of Food Atmosphere



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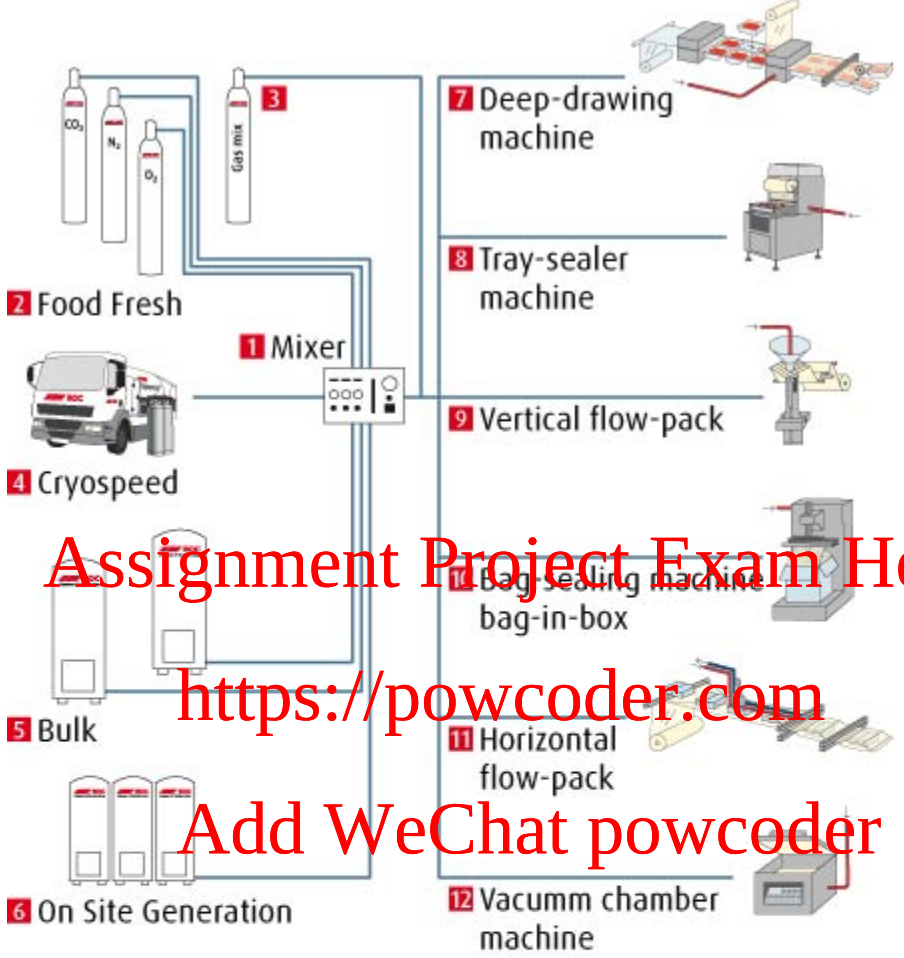

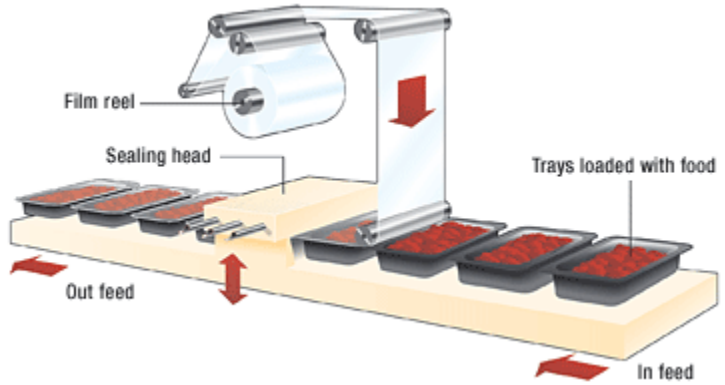

https://www.boconline.co.uk/en/processes/controlling-and-modifying-atmospheres/modified-atmosphere-packaging/index.html

http://supersealer.com.au/index/map-packaging/

Numbered parts - Key

1. Mixing panel
2. Gas source - Cylinders
3. Gas source - Pre mix cylinder
4. Gas source - Cryospeed
5. Gas source - Bulk
6. Gas source - On site generation
7. Packing machine - Deep drawing machine
8. Packing machine - Tray sealer
9. Packing machine - Vertical flow packer
10. Packing machine - Bag sealer
11. Packing machine - Horizontal flow packer
12. Packing machine - Vacuum chamber

Control by modified atmosphere

CAP: controlled atmosphere packaging

MAP: modified atmosphere packaging

AP: active packaging

VP: vacuum packaging

vacuum packed fish
note the tight fitting, thick plastic, packaging

Vacuum Packing (VP)

- product placed in a bag, air evacuated and residual O_2 absorbed (film must collapse on the surface entirely)
- Affects mainly fast growing aerobic microbes
- Anaerobes/Fac.Anaerobes, including any pathogens, are not greatly affected

Commonly used for meats – where VP + chill storage will allow **5x longer storage** compared to aerobically stored (and chilled) meats.

MAP: Modified Atmosphere Packaging

- Flush food / products packed with a gaseous mix of CO_2, N_2 and O_2
- CO_2 has inhibitory effect on many microbes
  - Water and carbon dioxide combine to form carbonic acid (H_2CO_3), a weak acid
- N_2 creates an inert atmosphere, retards microbial growth, and slows rancidity
- O_2 maintains oxy-myoglobin in packed meat (retains its bright red appearance)
- Actual ratios of gases vary depending on type of food.

MAP: Modified Atmosphere Packaging

A problem with MAP is that the gas composition can change during food storage as a result of:

- Product and microbial respiration
  e.g. removal of O_2 by aerobes/fac. anaerobes
- Dissolution of CO_2 into aqueous phase
- Differing rates of gaseous exchange across various types of packaging film / membranes

Such changes in gas composition can reduce the inhibitory effect of the initial gas mixture

Controlled atmosphere packaging (CAP)

To overcome the problems with MAP (where the gas composition can change over time),

a controlled gas environment of food/ product was developed.

In CAP, the gas is of constant composition throughout storage.

- e.g. apples/ pears are stored at sub-ambient temperature and transported under 10% CO_2

- CO_2 is effective in controlling mould growth and reduces ethylene

  (*ethylene promotes post-harvest ripening of fruits, so its control by CO_2 helps maintain/preserve fruit during transport/storage)

Controlled atmosphere packaging (CAP)

Usually this is done in large impervious containers, e.g. special shipping containers, or grain storage silos. Reducing the O_2 level is also of benefit for killing any insect pests/rodents that have managed to get into the food...

The gas composition is kept constant by continuous flushing or monitoring and adjustment.

AP: active packaging (‘intelligent packaging’)

- active components in packaging system interact with the contents or environment, to extend shelf life and quality
- e.g. moisture control, O_2 generators, CO_2 controllers, oxygen scavengers, odour removal

Extrinsic factors

Read about commercial active packaging

http://www.novipax.com/products/

Read about MAP products

http://supersealer.com.au/index/map-packaging/

https://www.boconline.co.uk/en/processes/controlling-and-modifying-atmospheres/modified-atmosphere-packaging/index.html

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