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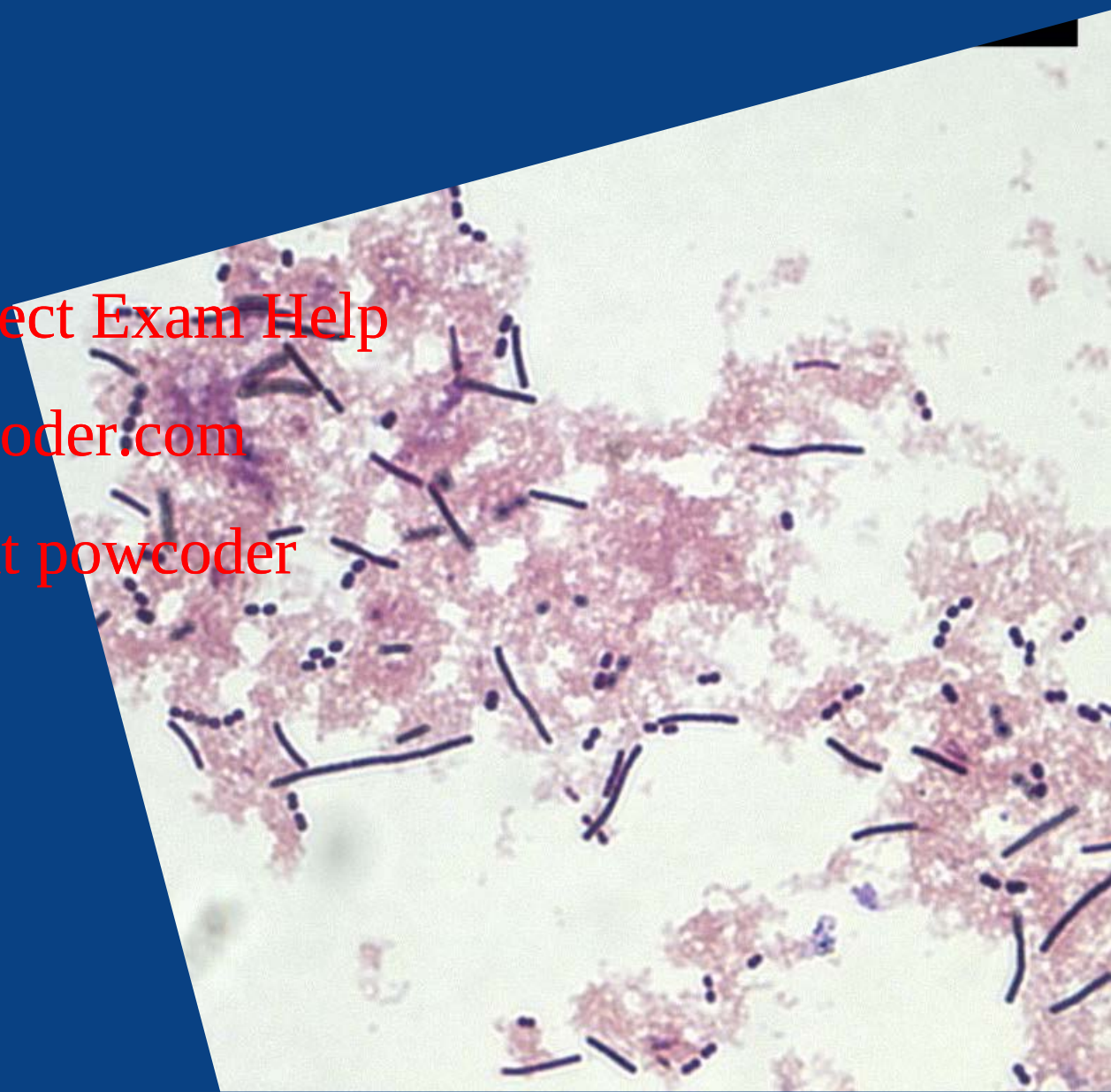
FOOD20006

Food Microbiology & Safety

Helen Billman-Jacobe



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Important groups of bacteria- function

Ray and Bhunia Ch 2

Intended learning outcomes

Identify and describe different categories of microbes with requirements for growth

Give examples of microorganisms for each category of growth requirements

Describe bacterial sporulation

Explain the procedures and application of endospore staining

List some compounds produced by bacterial metabolic processes

Important genera of bacteria

description	Genera
Gram-negative, aerobic/microaerophilic, motile, helical	*Campylobacter*
Gram-negative, aerobic, rods and cocci	*Pseudomonas, Xanthomonas*
Gram-negative, facultative anaerobic, rods	*Escherichia, Klebsiella, Salmonella*
Gram-positive, cocci	*Staphylococcus, Micrococcus, Lactococcus, Leuconostoc, Streptococcus*
Gram-positive endospore forming rods	*Bacillus, Clostridium*
Gram-positive, non-sporing, regular rods	*Lactobacillus, Listeria*
Gram positive, non-sporing, irregular rods	*Corynebacterium, Propionibacterium, Bifidobacterium*

Cell shape:	cocci, rods, helical
Cell wall:	Gram positive, Gram negative
Gaseous atmosphere affecting growth:	Aerobic, anaerobic, microaerophilic, facultative
Ability to form spores:	spore-former, non-sporing
Temperature:	is specific to each organism

Groups of bacteria by function

Characteristic	Subgroups
Acid they produce	*lactic, acetic, butyric, propionic*
Substrate they degrade	*proteolytic, lipolytic, saccharolytic*
growth temp	*psychro, meso, thermo*
extremophiles	*thermo, acidiuric*
cellular products	*gas,slime, spore*
oxygen requirement	*aerobe, anaerobe , facultative*

Growth temperature

Three main ‘temperature groups’ of microbes

Thermophiles optimum ~ 55°C; range 45-70°C

Mesophiles optimum ~ 35°C ; range 10-45°C

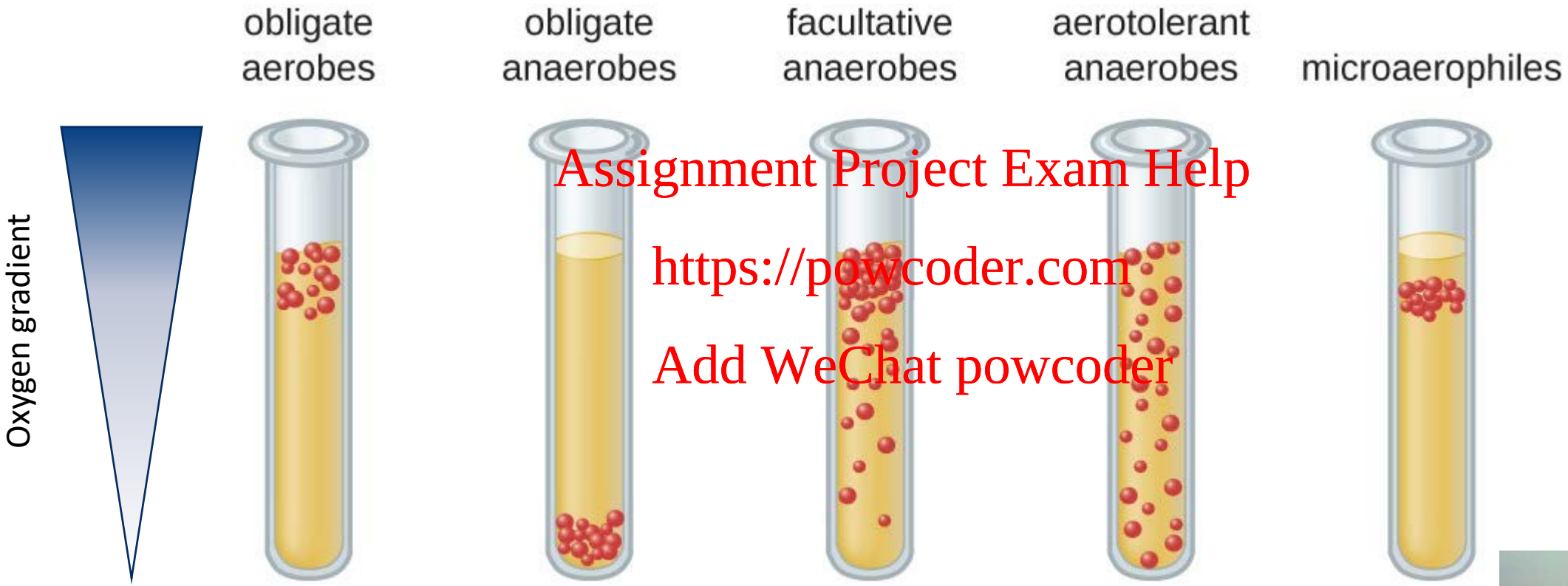
Psychrophiles optimum ~15°C ; range -5 to +20°C

Two more groups are also important in food microbiology:

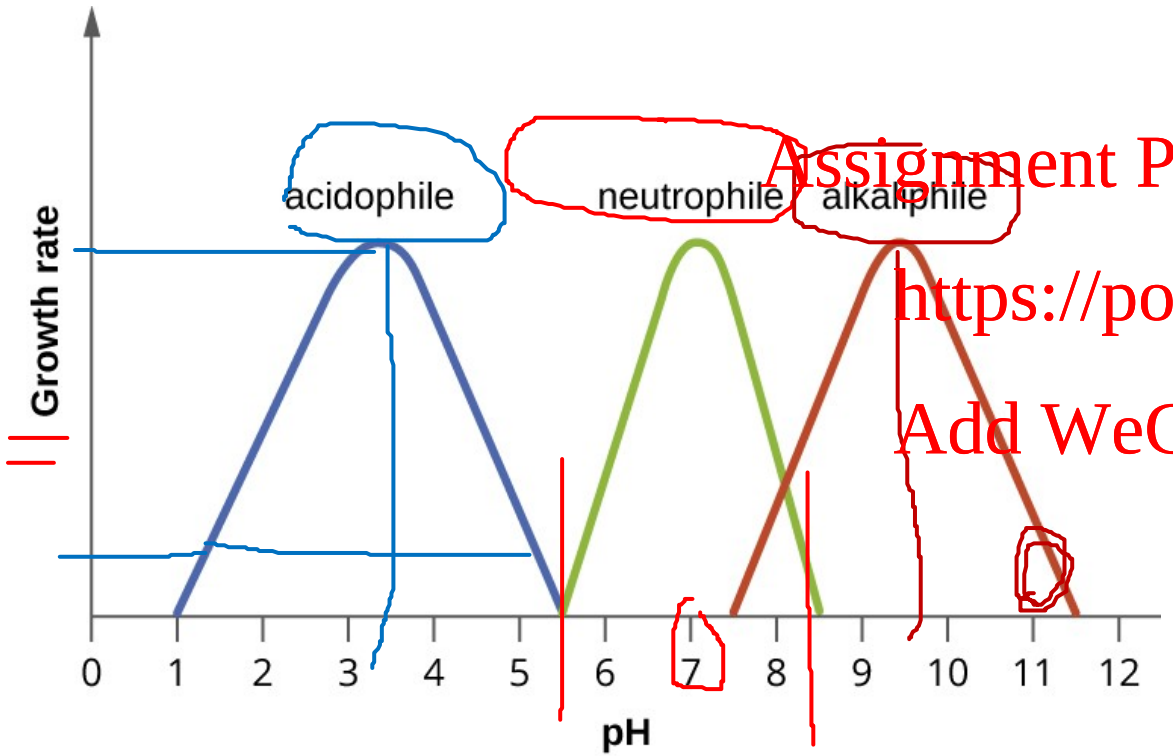
Psychrotroph – can grow at refrigerator temperature (0-5°C) regardless of their optimum growth temperature.

Thermoduric – can survive pasteurization heat treatments.

Optimum oxygen concentration



Effect of pH on growth



Most bacteria are neutrophiles : pH ~7

Escherichia coli, *staphylococci*, and *Salmonella* spp. are neutrophiles and do not do well in the acidic pH of the stomach.

Microorganisms that grow optimally at pH less than 5.55 are acidophiles.

Lactobacillus contribute to their acidic environment by producing lactic acid

Alkaliphiles, grow best at pH-8.0 -10.5.

Vibrio cholerae, the pathogenic agent of cholera, grows best at the slightly basic pH but can survive pH11.0

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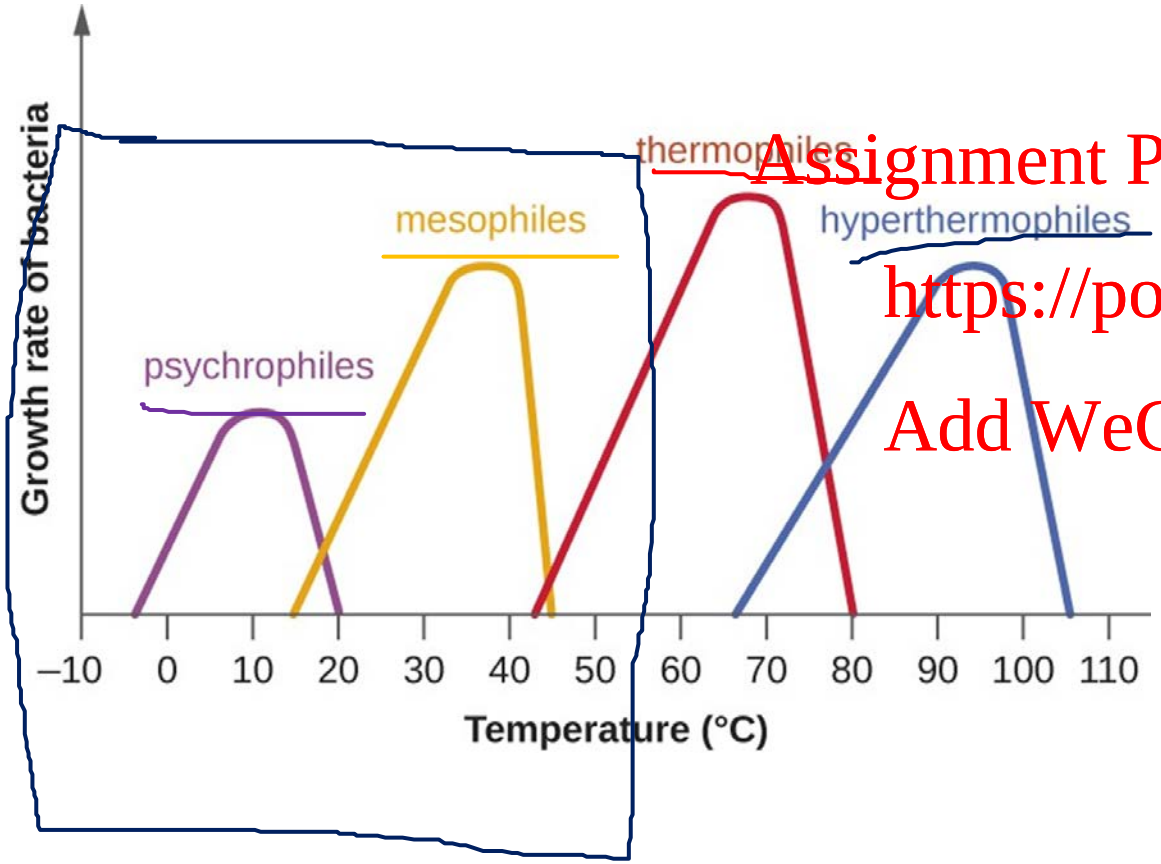
Growth temperature



optimum growth temperature: the temp where growth rates are the highest

minimum growth temperature: the lowest temperature at which the organism can survive and replicate

maximum growth temperature: highest temperature at which growth can occur

permissive growth temperatures: range where growth can occur

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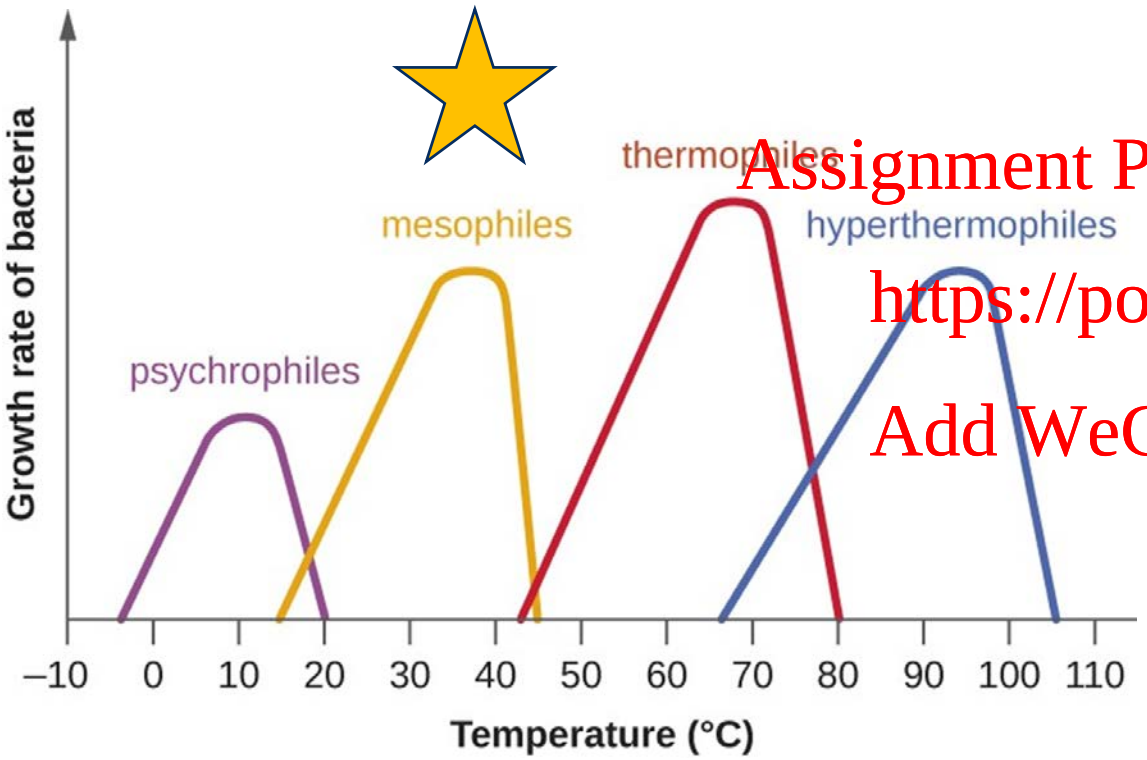
Growth temperature: Mesophiles



Mesophiles: “middle loving”

-moderate temperatures

-~20 -45°C

-normal human microbiota

- Human pathogens

E. coli, *Salmonella spp* and *Lactobacillus spp*

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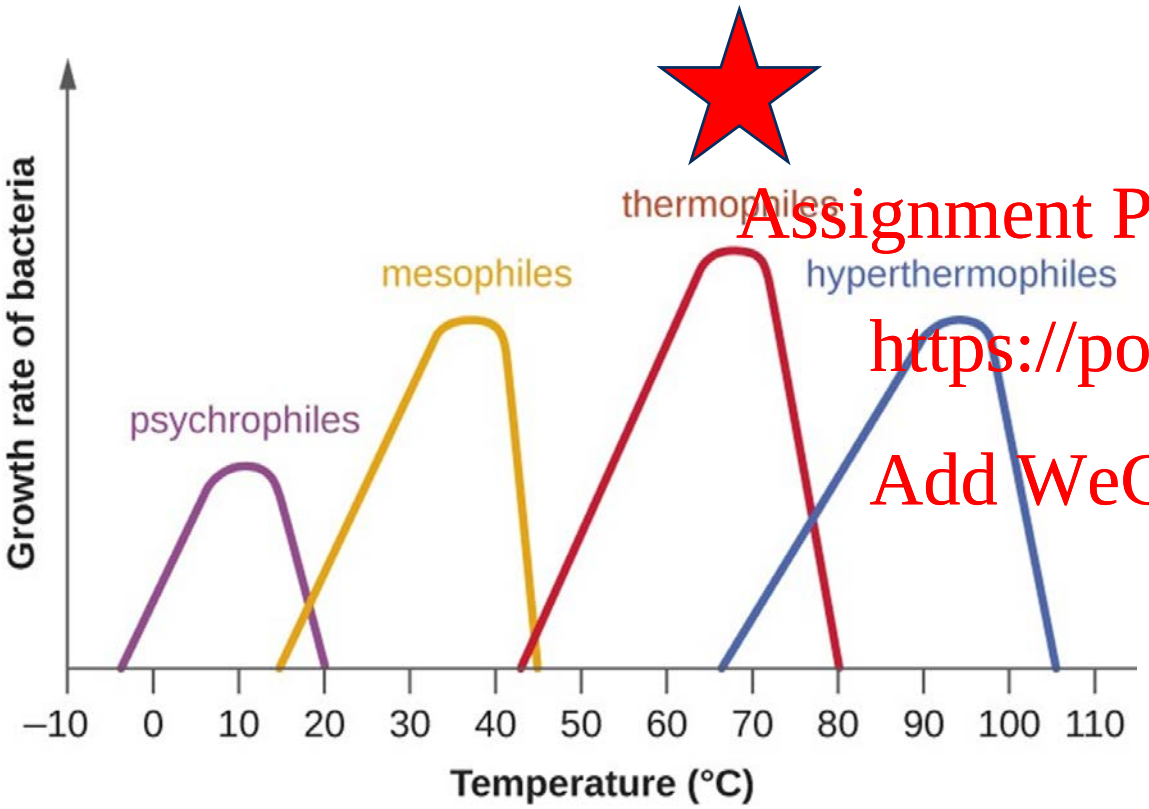
Growth temperature: Thermophiles and thermodurics



Thermophiles: “heat loving”

-high temperatures

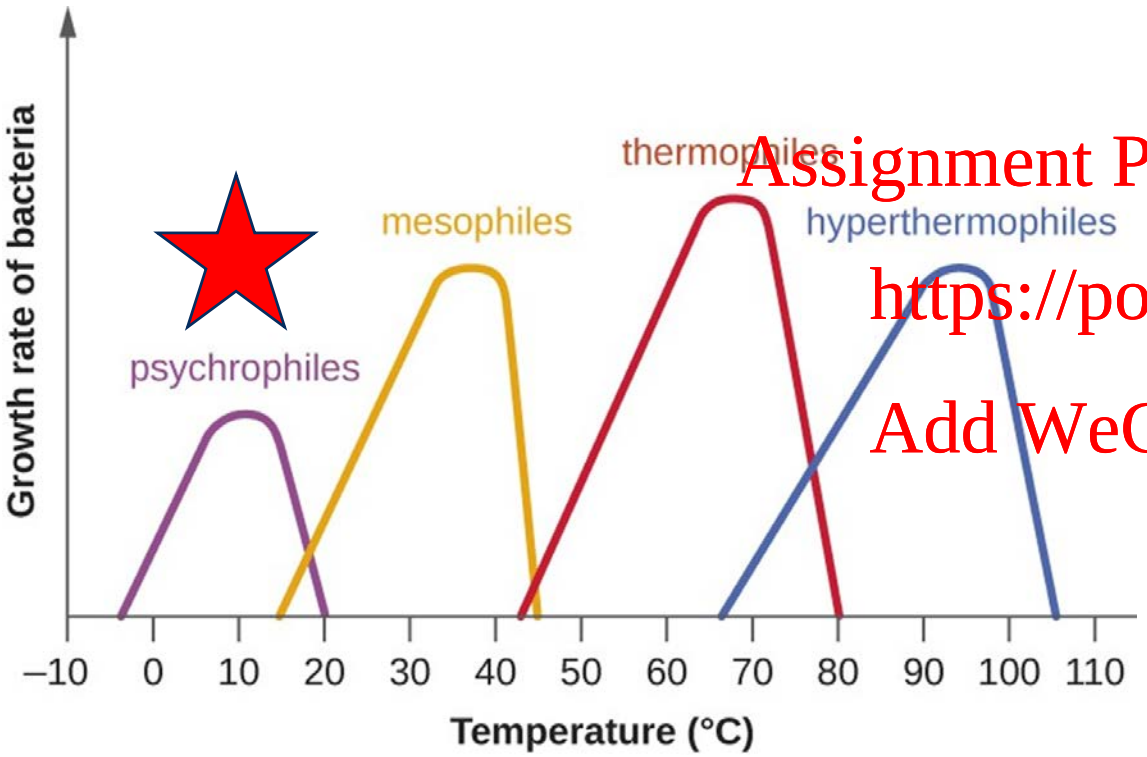
-~50 -80°C

-do not multiply at room temp

Thermophiles are widely distributed in hot springs, geothermal soils, and manmade environments such as garden compost piles

Thermodurics grow at lower temps but can survive (but not grow) at elevated temps

Growth temperature: Psychrophiles and psychrotrophs



Psychrophiles: "cold loving"

-low temperatures

-~0 - 15°C

-do not survive at room temp

Psychrotrophs: prefer ~25 °C but will grow at refrigeration temperature about 4 °C.

- responsible for the spoilage of refrigerated food.

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Sporulation

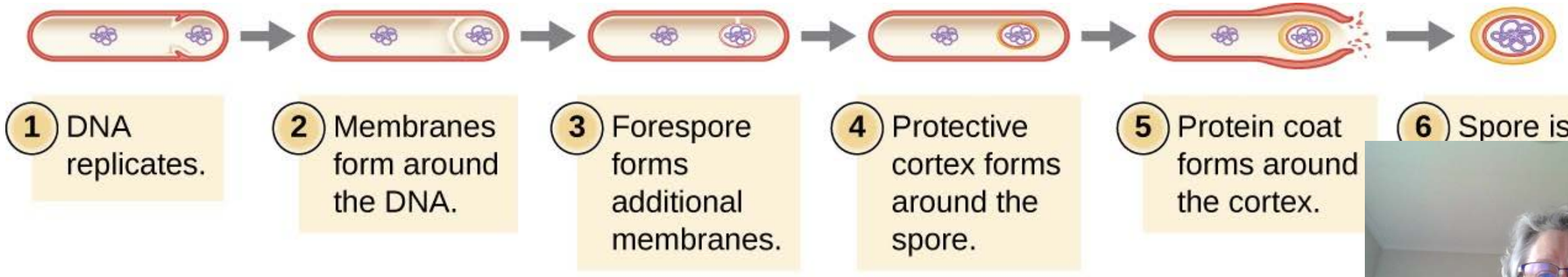
Some bacteria are able to form endospores when environmental conditions are unfavourable for growth

Sporulation is the process by which vegetative cells change into endospores

Endospores protect the bacterial genome in a dormant state

Endospores survive long periods without nutrients or water, as well as exposure to chemicals, extreme temperatures, and even radiation

Endospores present a practical problem in the food industry because they are very difficult to kill



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Endospore staining

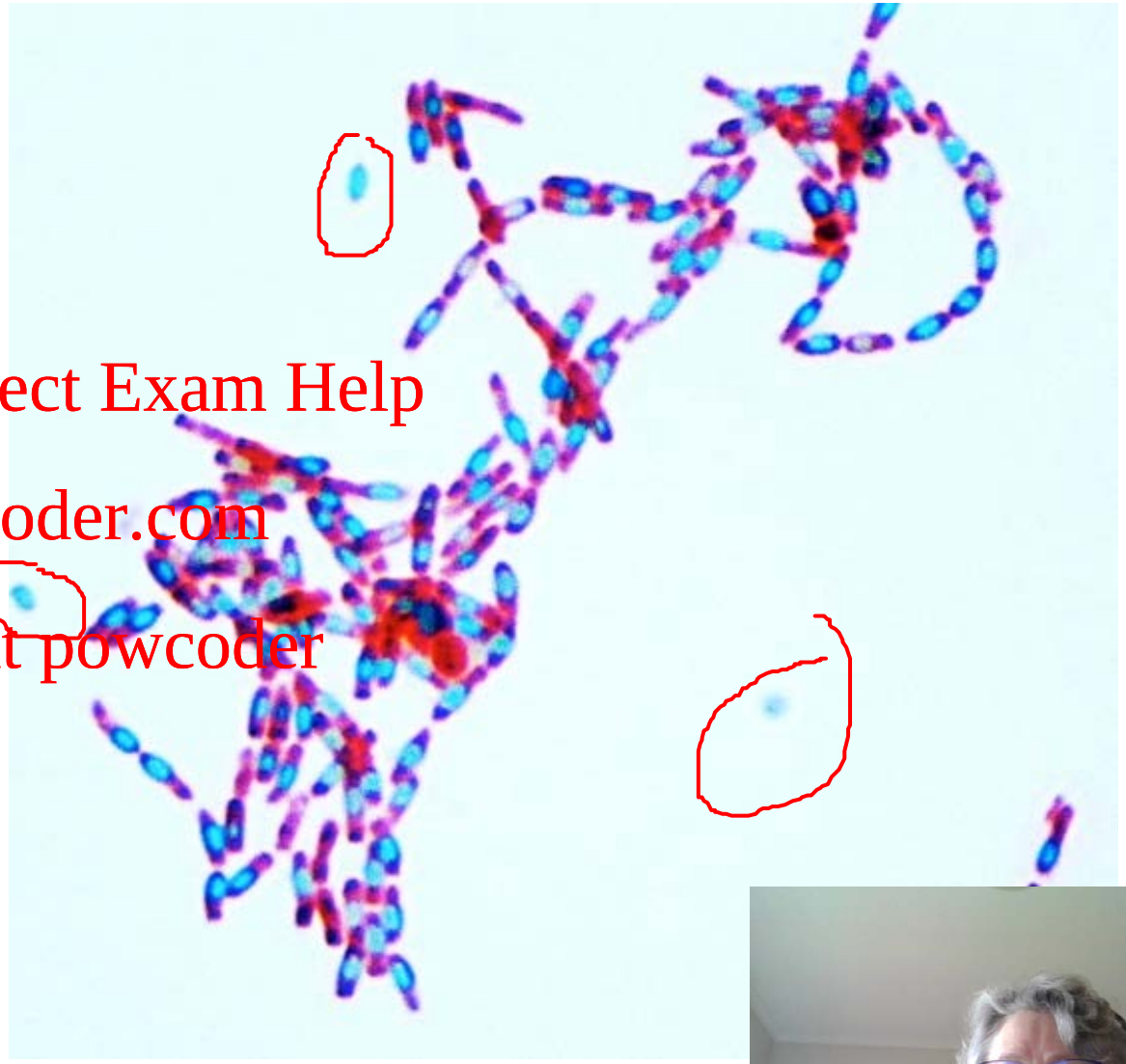
Endospores are clear when cells are stained with the Gram stain.

Endospore staining uses two stains to differentiate endospores from the rest of the cell. Heat is used push the primary stain, malachite green, into the endospore.

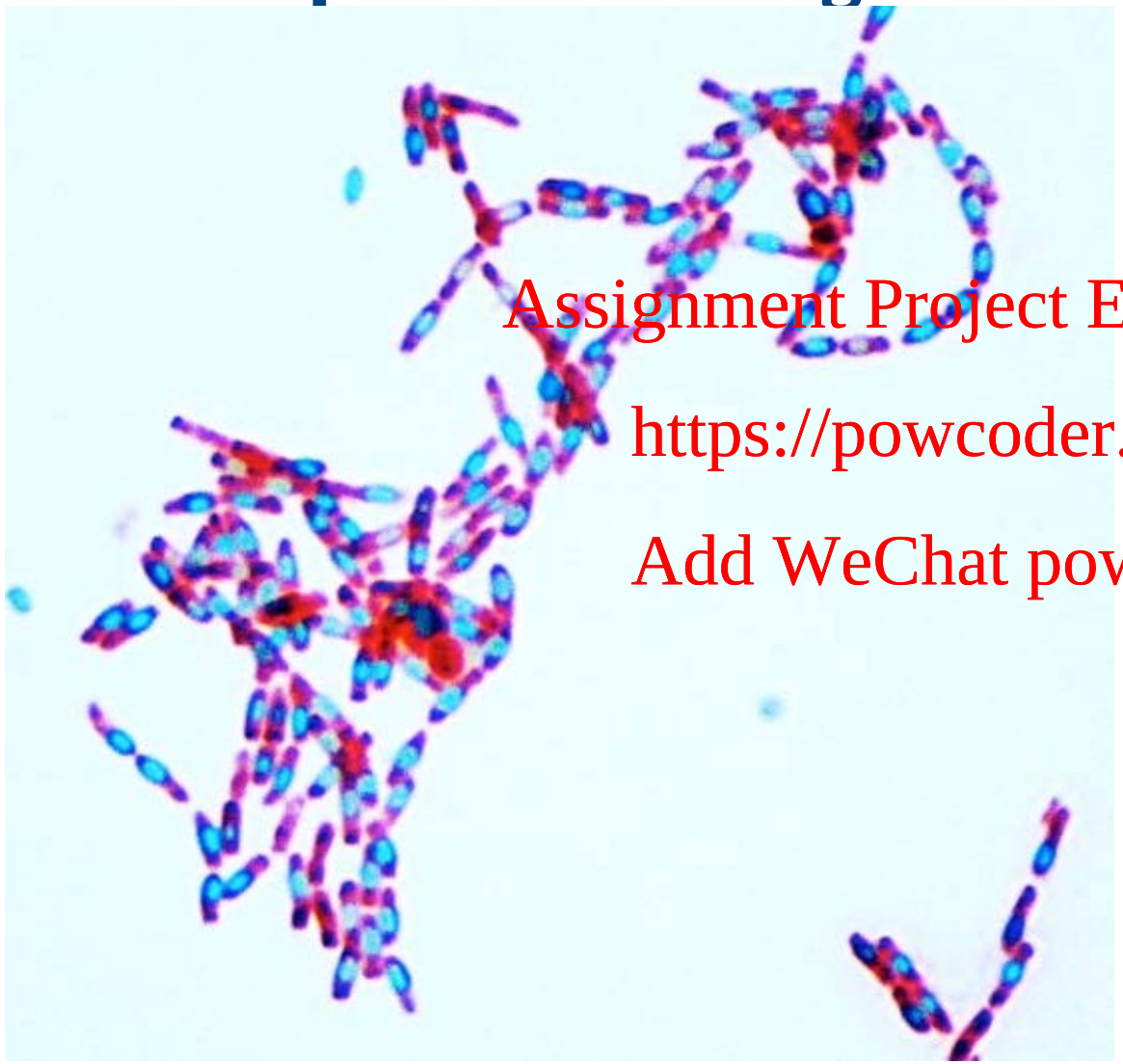
Washing with water decolorizes the cell, but the endospore retains the green stain.

The cell is then counterstained pink with safranin.

Endospore-staining techniques are important for identifying *Bacillus* and *Clostridium*, two genera of endospore-producing bacteria that contain clinically significant species.



Endospore staining



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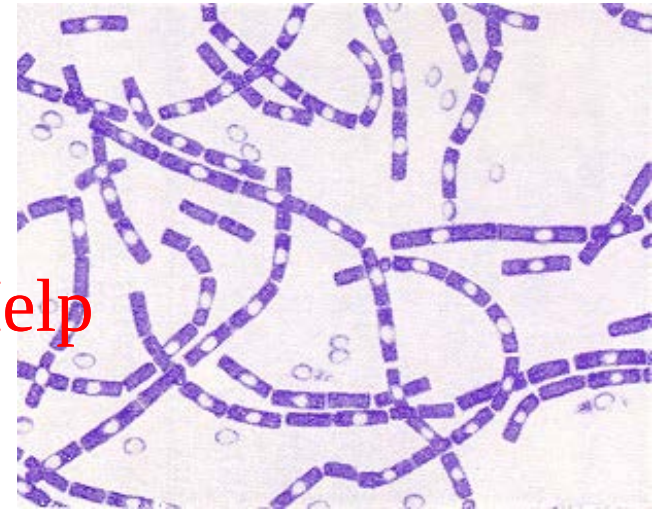

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Important groups of bacteria

description	Genera	
Gram-negative, aerobic/microaerophilic, motile, helical	*Campylobacter*	✓
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Gram-positive, cocci	*Staphylococcus, Micrococcus, Lactococcus, Streptococcus*	✓
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Gram positive, non-sporing, irregular rods	*Corynebacterium, Propionibacterium, Bifidobacterium*	✓
Acid producers	***lactic, acetic, butyric, propionic***	
Degradative	***proteolytic, lipolytic, saccharolytic***	
Growth temperature	*psychro, meso, thermo*	✓
Cellular products	***gas, slime***, *spore*	
Oxygen requirement	*aerobe, anaerobe , facultative*	✓
Extremophiles	*thermo, aciduric*	✓

Cellular products - gas

Cellular products: ***gas,*** *slime, spore*

Gas-producing bacteria: some bacteria produce gas as a product of their metabolism. CO_2, H_2, H_2S

Example of a gas producer

Propionibacterium freudenreichii is used to make Swiss cheese

- lactate converted to form acetate, propionate, and carbon dioxide
- the carbon dioxide is responsible for forming the holes in the cheese

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Cellular products - slime

Cellular products: *gas, **slime**, spore*

Slime-producing bacteria: Slime producers synthesise polysaccharides. The function of the polysaccharides to provide a protective coating to the cell

examples of slime producers

Xanthomonas campestris produces a polysaccharide gum called xanthan which is used as a thickening agent in food processing. It is often used to create a pleasant texture of ice cream

Xanthan gum is produced by fermentation of glucose, sucrose, or lactose

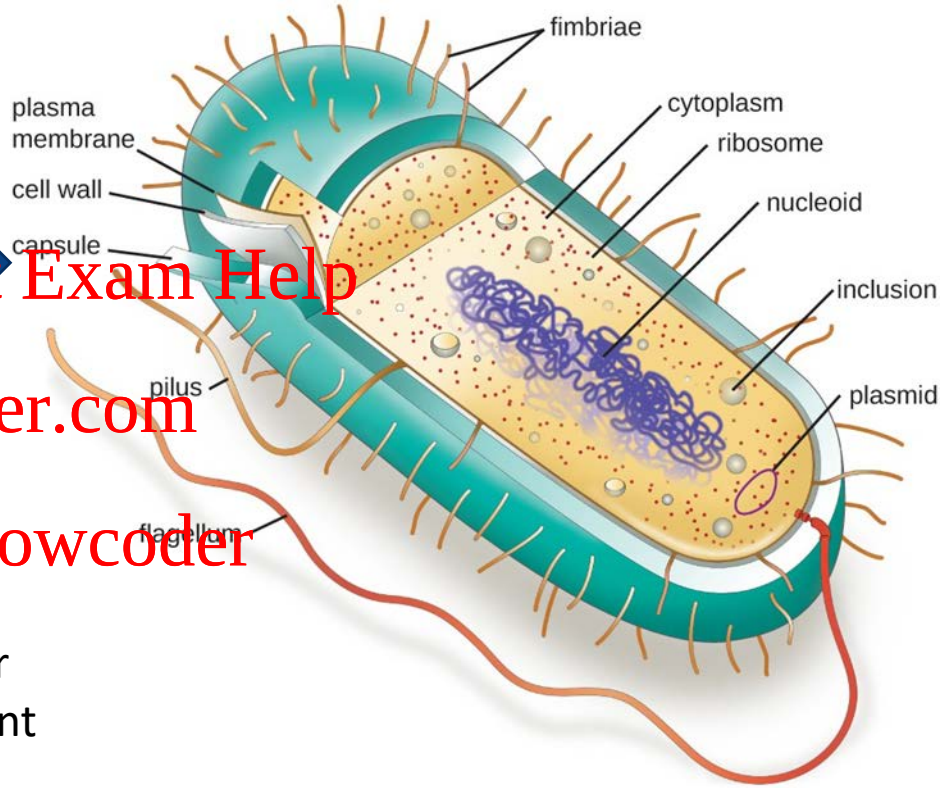
Cellular products – slime vs capsules

Capsules and slime layers.

Many bacterial cells secrete extracellular material in the form of a capsule or a slime layer.

Slime is loosely associated with the bacterium and can be easily washed off.

A capsule is attached tightly to the bacterium



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The ability to determine whether cells have capsules is an important diagnostic tool. Capsules do not absorb most basic dyes; therefore, a negative staining technique (staining around the cells) is typically used for capsule staining.

Degradative

Degradative: ***proteolytic, lipolytic, saccharolytic***

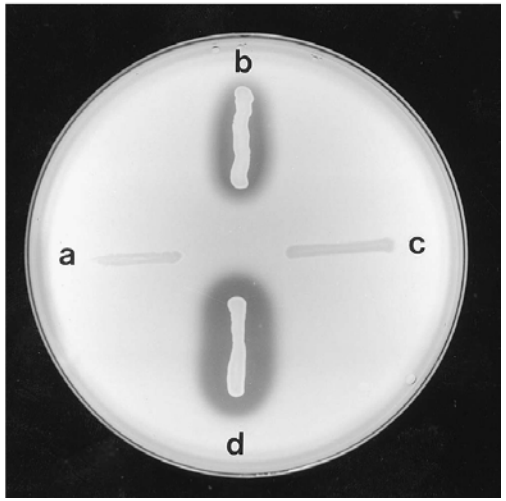
Large molecules cannot be taken up by the bacterial cells but small hydrolytic products can be absorbed by the cells and used as nutrients.

Proteolytic microorganisms secrete enzymes which can hydrolyse proteins.

Lipolytic organisms produce extracellular lipases and hydrolyse triglycerides

Saccharolytic organisms hydrolyse complex carbohydrates.

These organisms can be important in food spoilage



Billman-Jacobe et al 1995 AEM

Acid producers

Propionic acid is produced by *Propionibacterium freudenreichii.* It imparts a nutty flavour to dairy fermentations

Acetic acid is produced by *Acetobacter aceti* and is used for making vinegar

this

Lactic acid bacteria produce large amounts of lactic acid from carbohydrates. This group are very important in food microbiology and are often referred to as LAB. The species are mainly from the genera *Lactococcus, Leuconostoc, Pediococcus, Lactobacillus* and *Streptococcus.*

LAB will be studied in more detail later in the course

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