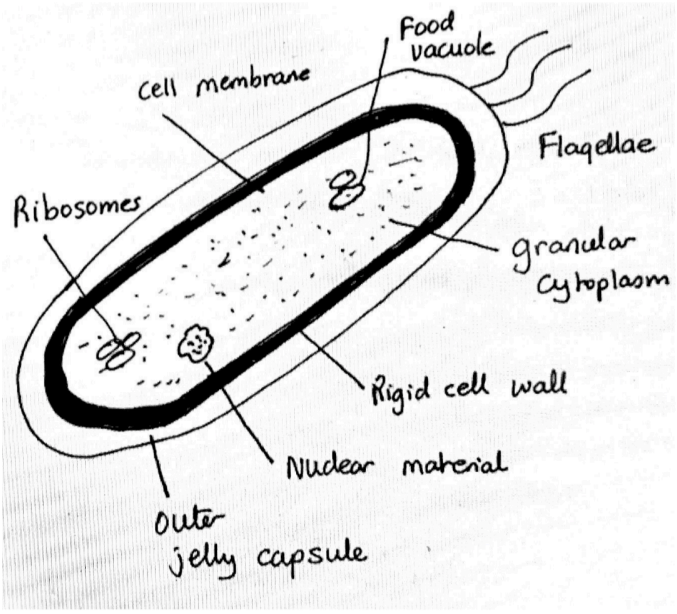
BACTERIA/FOOD POISIONING - 1.3.8

- Bacteria are single-celled organisms (unicellular).
- They occur in air/soil and water.
- Found also on plants and in animals.
- In humas they are present (nose, mouth, throat, skin, bowel).
- Bacteria particularly like moist foods (eg) : milk, stock, raw meat and fish.
- They have both beneficial and harmful effects.
- Bacteria do not have chlorophyll therefore they cannot make their own food; it must be got from an outside source.
- On the Home Economics course, we study Saprophytic Bacteria which secrete enzymes into dead or decaying matter to obtain food.

STRUCTURE OF A BACTERIAL CELL



- The bacterium has a jelly like capsule surrounding it to protect it against Hydrochloric Acid in the stomach. Not all bacteria have this.
- Some bacteria are mobile and have flagellae so they can move around in liquid. They are gram negative bacteria.
- There is an outer rigid cell wall, protects the bacteria from pressure, helps maintain shape.
- Inside the cell wall is a cell membrane.
- The bacterial cell is filled with liquid granular cytoplasm.
- Ribosomes are suspended in the cytoplasm, they are needed for protein synthesis.

- Nuclear material, known as a nucleoid in bacteria. Nucleoids assist in cell development and growth of the bacterial cell.
- It contains enzymes and proteins.

STRUCTURE OF A BACTERIAL CELL

- The most common way of classifying bacteria is according to :

1 : SHAPE

(A) : Spirals

- Appear under the microscope as definitive and regularly curved rods – they can be shaped from a comma to a coiled spring.

(B) : Cocci (singular = coccus)

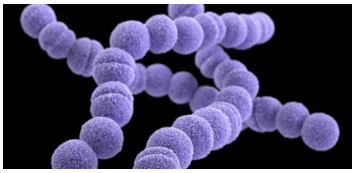
- Cocci are spherical in shape and appear as dots or circular under the microscope.

Diplococci

- The cocci appear in pairs (can cause pneumonia)

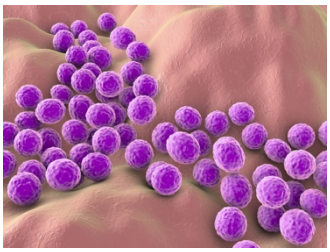
Streptococci

- Consist of chains of cocci (responsible for sore/'strept' throat infections)



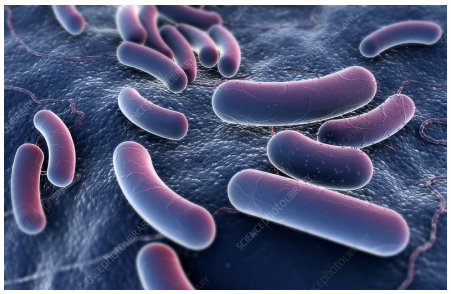
Staphylococci

- Cocci are arranged in clusters, can cause skin infections (eg) : boils, food poisoning (staphylococci aureus)



(C) : Rods

- Appear as cylinders with rounded ends (under the microscope).
- Sometimes Calle Bacilli (singular bacilli) (eg) : Lactobacillus bacteria.
- The bacillus that causes TB belongs to this group.



2 : TEMPERATURE RANGE

- Bacteria can also be classified according to the temperature range which they flourish at (ie) : optimum temperature for growth.

(A) : Psychrophiles

- - 20°C + 10°C (eg) : Listeria.

(B) : Mesophiles

- 20°C. 45°C (eg) : Salmonella.

(C) : Thermophiles

- Optimum Temperature 75°C (eg) : Clostridium Botulinum

3 : PATHOGENIC / NON-PATHOGENIC

(A) : Pathogenic

- Pathogenic bacteria cause disease (eg) : TB.

(A) : Psychrophiles

- Non-pathogenic are harmless and non-disease causing (eg) : Lactobacillus Bulgaricus.

4 : GRAM POSITIVE / GRAM NEGATIVE

- Gram staining is another way of classifying bacteria (named after it's inventor Christian Gram!)

(A) : Gram + Bacteria

- Produce spores.
- Low resistance to antibiotics.
- Immobile.
- Clostridium Botulinum.

(B) : Gram - Bacteria

- Do not produce spores.
- High resistance to antibiotics.
- All mobile, have flagellae.
- Aerobic + Anaerobic.
- E.Coli, Salmonella.

FOOD POISONING BACTERIA (Q2) 2013

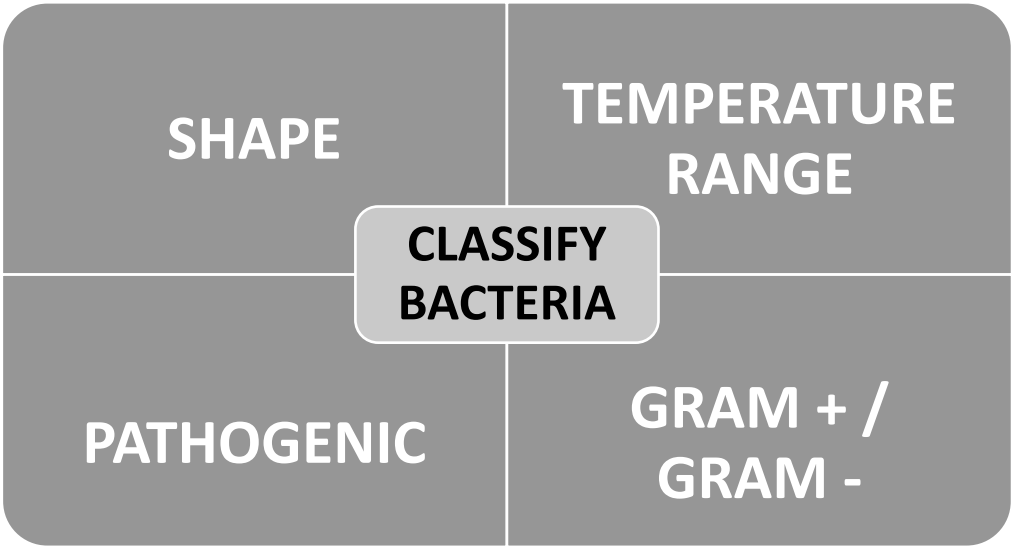
	SALMONELLA	CLOSTRIDIUM BOTULINUM	LISTERIA
Food/Sources	Poultry, Ice-Cream, Eggs, Sausages, Faces (Animal/Human), Soil.	Meat, Fish (protein foods), Vacuum Packed Food, Canned Foods.	Soft Cheese, Cook Chill Food, Seafood, Ice-Cream, Meats.
Incubation Period	12-36 Hours.	Usually 12-36 Hours but maybe 2 Hours to 8 Days.	Average 2 Weeks (1-70 Days)
Symptoms	Fever, Diarrhoea, Abdominal Pain, Vomiting.	Attack on CNS, Blurred Speech, Blurred Vision, Asphyxiation, Paralysis.	Septicaemia (Blood Poisoning), Fever, Meningitis (Infants)
Duration of symptoms	1-7 Days.	Recovery 6-8 Months (may die if antidote is not taken)	Slow Recovery
Type of Food Poisoning	Infectious (ie) : Salmonella are ingested (Endotoxins)	Toxic (ie) : Toxin is ingested (Exotoxins)	Infectious
Temperature range	Mesophile	30°C -37°C	Likes Temperatures Above 5°C.
Name of poisoning	Salmonellosis	Botulism	Listeriosis
	dislikes salt / pH 6.5 gram – (Rod)	pH 4.6 / anae gram + (Rod)	Facultative anaerobic . gram – Rod

FOOD POISONING BACTERIA 2019

	CAMPYLOBACTER	E.COLI 0157
Food Sources/Sources	Poultry (handling raw poultry or eating undercooked poultry). Cross Contamination	Undercooked Mince Meat (eg) : Burgers. Meat, Vegetables, Milk or Water contaminated with animal faeces.
Incubation Period	2-5 Days after exposure to bacteria.	1-10 Days.
Temperature Range	Mesophile, 30°C - 45°C	Mesophile, 37°C
Symptoms	Nausea, Vomiting, Bloody Diarrhoea, Headache (NB)	Abdominal Pain, Cramps, Nausea, Diarrhoea, Severe Cases (Children) - Kidney Failure.
Duration of Symptoms	Up to one Week (7 Days)	5-10 Days.
Type of Food Poisoning	Infectious Food Poisoning	Infectious Food Poisoning
Name of Food Poisoning	Campylobacteriosis caused by Campylobacter Jejuni	Haemorrhagic Collitis

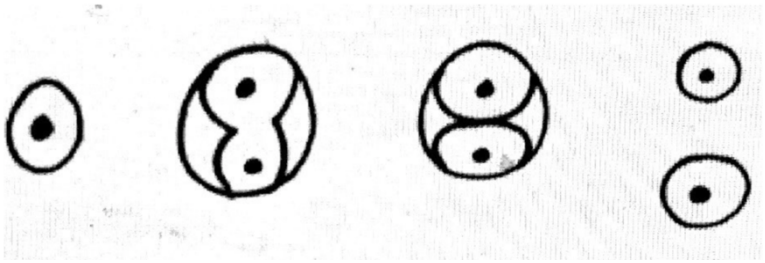
Incubation Period : The time from exposure to onset of symptoms of food poisoning

(NB) : Complications with Campylobacter food poisoning are rare but 1 in 1000 cases lead to a neurological disorder called Guillain-Barre Syndrome.



REPRODUCTION (GROWTH)

- Bacteria reproduce by simple **Binary Fission**.
- A mature bacteria cell having reached its maximum size divides to give two identical cells each having half the maximum size.
- When these cells reach maturity they each divide again by Binary fission.

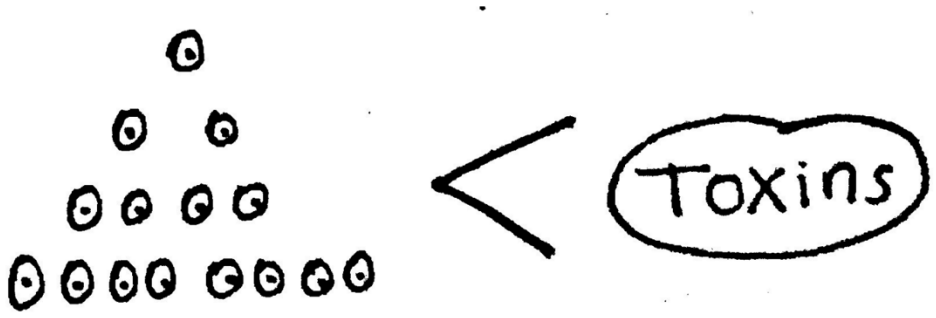


NOTE : Under favourable conditions this process may proceed rapidly (up to one division each twenty minutes)

- Bacteria grow in colonies (large groups of bacteria)
- Each colony can contain millions of bacterial cells.
- Colonies of bacteria are visible to the naked eye but a microscope is necessary to identify individual bacteria.

TOXINS

- Toxins are poisonous waste products manufactured during cell division (ie) : rapid cell division.
- The toxins may damage cells of the infected host :
  - Humans.
  - Foods.
- In humans, toxins may cause food poisoning, even death.



- Sometimes toxins are produced inside the body (eg) : Salmonella, bacteria ingested into the body on chicken. The Salmonella bacteria are mesophiles and flourish at body temperature. The bacteria reproduce rapidly and produce toxins. These toxins make the person ill (ie) : vomiting, diarrhoea **(infectious food poisoning)**.

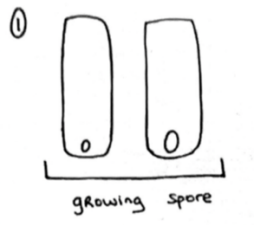
- In cases where bacteria reproduce outside of the body (eg) : Clostridium Botulinum, bacteria produce toxins inside cans (anaerobic). The humans then ingests the toxin.
- **NOTE** : Toxins from Clostridium Botulinum may kill humans.
- This is an example of **(toxic food poisoning)**.

- Bacteria cannot multiply rapidly for long as :
  - **(A)** : Bacteria run out of food.
  - **(B)** : Overcrowding (bacteria are competing for air, food and moisture)
  - **(C)** : Toxins will eventually retard and stop the growth of bacteria eventually causing death.

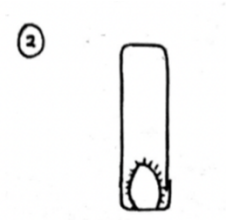
- Bacilli and Clostridia (rods) produce spores (endospores).
- Endospores are tough, dormant cells.
- Difficult to destroy (canning 121°C/15min destroys them).
- Endospores are produced when unfavourable conditions exist (ie) :
  - No food.
  - No oxygen.
  - No moisture.
  - Toxins present.

FORMATION OF AN ENDOSPORE

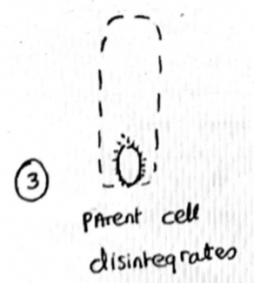
1) An endospore begins as a small area within a bacterium.



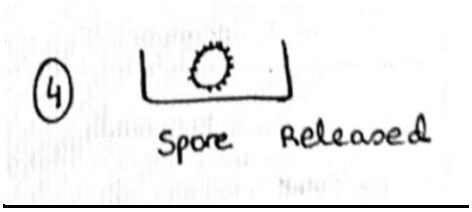
2) Endospore increases in size



3) Grows a tough wall of protein around itself. Parent cell disintegrates.



4) Released from the parent cell as an endospore. Spore is released



IMPORTANCE OF BACTERIA

- Yoghurt, cheese production (Lactobacillus Bulgaricus,Lactobacillus Helveticus).
- Stage 2 of Vinegar production where Acetobacter bacteria are added to alcohol eg red wine,cider etc.
- Produce Vitamin B and K in the intestine.
- Break down waste into simple compounds eg break down organic matter (vegetable/fruit peelings) to organic compost for gardens.

DISADVANTAGES OF BACTERIA

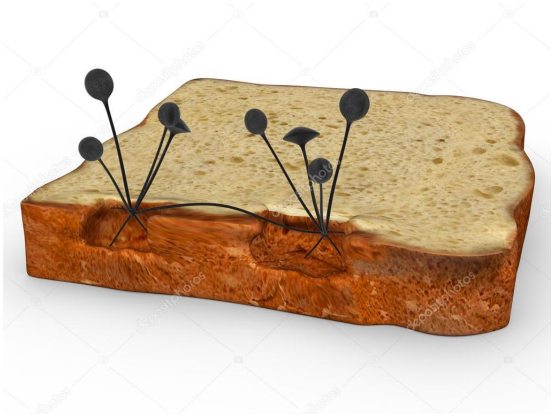
- Spoilage of food (eg) : produce Trimethylamine (fish),cause souring of milk.
- Diseases – Meningitis, Whooping Cough, Typhoid, Cholera.
- Food poisoning – Botulism, Listeriosis.

IMPORTANCE OF FUNGI

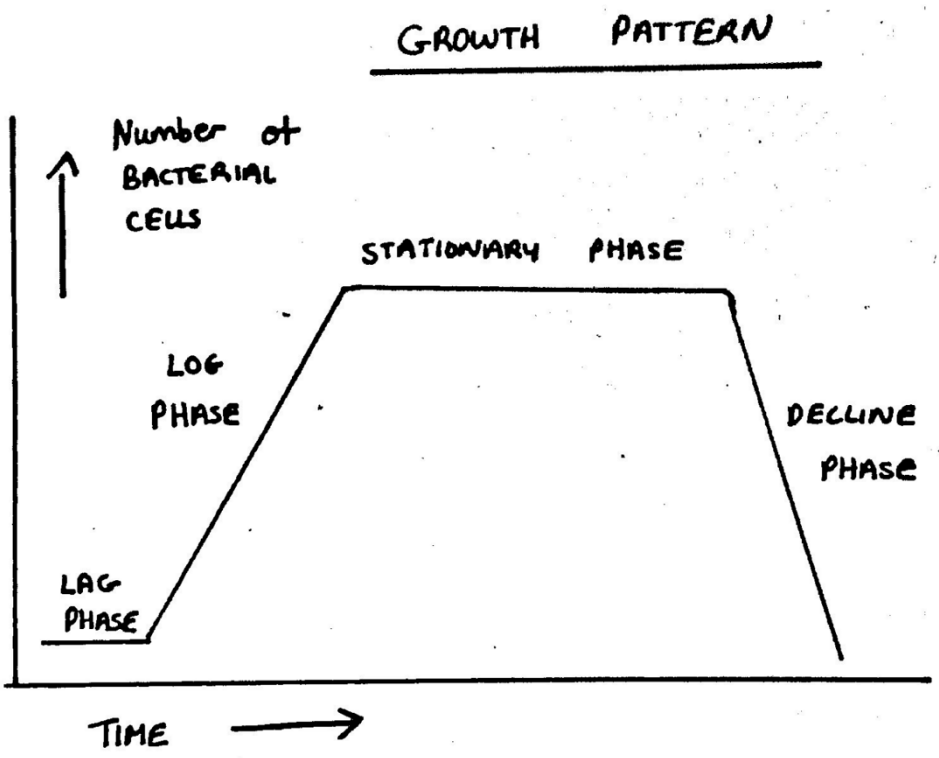
- Used in the manufacture of cheese (eg) : Penicillium mould.
- Antibiotics (eg) : Penicillin.
- Yeasts – Brewing, Breadmaking. Rich source of Vitamin B (tonics, supplements)
- Many fungi are edible (eg) : truffles, mushrooms.

DISADVANTAGES OF FUNGI

- Some are poisonous to humans (eg) : Death Cap,Panther Cap mushrooms are deadly poisonous.
- Plant diseases (eg) : Dutch Elm.
- Causes food spoilage (eg) : Mucor (Bread Mould),soft rot on vegetables (Aspergillus Mould).
- Causes human disease (eg) : Athletes food, Ringworm.



BACTERIA GROWTH PATTERN



A : LAG PHASE

- Bacteria settle into their new environment.

B : LOG PHASE

- The bacteria reproduce at a rapid rate as suitable growth conditions exist (divide every 20 minutes)

C : STATIONARY PHASE

- No increase in number of bacteria as the production of new bacteria replaces the death of other bacteria. Competition for food, Oxygen and Moisture begins. Toxins are present.

D : DECLINE PHASE

- Number of bacteria falls as unfavourable conditions exist.

NOTE : If asked to discuss 'Growth' of bacteria in an exam question, structure answer under the following headings :

- Binary Fission (Include Diagrams)
- Production of Toxins.
- Growth Pattern (Include Diagram & Written Note)

TYPES OF FOOD POISONING

1: TOXIC FOOD POISONING	2: INFECTIOUS FOOD POISONING
● Bacteria reproduce outside the body (eg) : tinned food/canned salmon, tuna. ● Therefore, they produce toxins outside of the body = **Exotoxins**. ● Toxins are then ingested by humans. ● Boiling food that is contaminated is essential to destroy the toxins which are difficult to destroy. ● Symptoms develop quickly (even as quickly as two hours after ingesting the toxin).	● Bacteria are ingested into the body and reproduce inside the body (@ 37°C Mesophiles) ● Therefore, they produce toxins inside of the body = **Endotoxins**. ● The toxins make people ill (ie) : symptoms of food poisoning. ● Normal cooking temperatures will destroy both the bacteria and the toxins ,therefore easy to destroy. ● Symptoms may take a number of hours to develop (up to 12 hours).
○ **Example** : Clostridium Botulinum (Botulism)	○ **Example** : Salmonella (Salmonellosis), Campylobacter (Campylobacteriosis)

TYPES OF FERMENTED FOODS

- Micro-organisms have beneficial uses in the production of food.
- Fermented foods are produced as a result of :
  - **A** : Lactic Acid bacteria (eg) : Lactobacillus.
  - **B** : Yeast.

- All organisms require energy to live.
- Respiration is the term given to this process where energy is released from food.
- Aerobic respiration requires oxygen.

Glucose + Oxygen $\rightarrow$ CO_2 + water + energy

- Anaerobic respiration takes place without the presence of oxygen.

Glucose $\rightarrow$ Co_2 + alcohol or

lactic acid or

another organic acid + a small amount of energy

NOTE : Fermentation occurs during anaerobic respiration.

- The end products of respiration will determine uses in food production.

(A) : Alcohol

- Used to make wine, beer.

(B) : Lactic Acid

- Yoghurt, cheese, vinegar & pickled products.

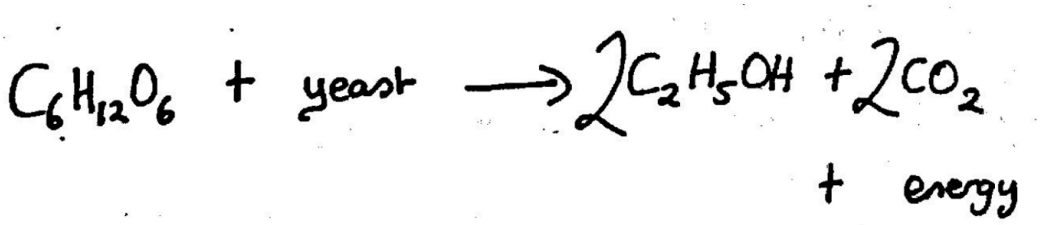
(C) : Carbon Dioxide (CO_2)

- Used in breadmaking.

YEAST FERMENTATION

BREAD

- Revise **Saccharomyces Cerevisiae**.
  - Fermentation (equation).
  - Action of enzymes in fermentation.
  - Chorleywood process.
  - Improvers.



BEER

- Yeast (Saccharomyces Cerevisiae) breaks down malted barley, water and flowers from the hop plant to produce alcohol (beer).
- Saccharomyces Carlsbergenis.

WINE

- Yeast breaks down sugars and grapes.

VINEGAR

- **NB** : Two Stage Fermentation.
- **Stage 1** : Yeast converts sugars into alcohol (anaerobically).
- **Stage 2** : Alcohol is converted to acetic acid by bacteria called acetobacter
  - Wine Vinegar – Acetobacter grow on the surface of wine.
  - Malt Vinegar – Acetobacter grow on the surface of beer.

LACTIC ACID FERMENTATION

UNDERLYING PRINCIPLE

- The disaccharide lactose in milk can be split into two monosaccharides glucose and galactose by bacterial enzymes. The bacteria usually belong to the culture Lactobacillus.

CHEESE

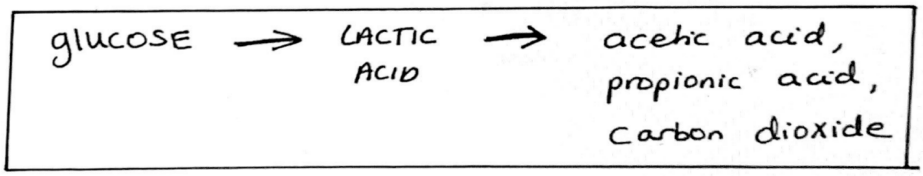
- A starter of Lactobacillus bacteria (Lactic Streptococci) is added to pasteurised milk to speed up the conversion of lactose to lactic acid.
- Milk is heated to 30°C.
- Rennin is added which coagulate milk protein to form curds (see 'Cheese' Handout).

YOGURT

- A starter culture of Lactobacillus Bulgaricus is added to pasteurised milk.
- The milk is heated to 37°C beforehand.
- The bacteria break down lactose to lactic acid.
- Lactic acid sours the milk and slightly thickens it (casein coagulates).
- **NOTE** : Acidophilus and Bifidus are added to bio-yogurt. Other fermented milk products include cultured buttermilk. See "Milk Products" Handout.

FERMENTATION BEYOND LACTIC ACID

- Some bacteria can ferment glucose beyond lactic acid to propionic acid, acetic acid and CO_2 (carbon dioxide).
- **OR** acetic acid, butyric acid, ethyl alcohol, butyl alcohol, acetone, CO_2 and hydrogen.



- The above fermentation process is used in the production of :
  - Sauerkraut (pickled cabbage).
  - Pickled onions and other pickled vegetables.
  - Kimchi (Korean pickled cabbage).

Sauerkraut

Kimchi