Microbiology

Food spoils in two ways:
1) on the outside - through action of micro-organisms
2) on the inside - through the action of enzymes.

Micro-organisms are tiny living organisms that are found everywhere but cannot be seen with the naked eye.

Micro-organisms are classed into 3 groups:
1) Fungi - moulds, yeasts & large fungi
2) Bacteria - Salmonella & E. Coli
3) Viruses - like those which cause influenza

Some micro-organisms can cause food poisoning - these are called pathogenic (disease causing) bacteria

Other micro-organisms are beneficial to humans - provide vitamin help decaying matter and are part of food production eg yoghurt

Conditions needed by microbes to grow:

① Food
Microbes can be classed as
a) Saprophytic - feed on dead or decaying matter eg fungi
b) Parasitic - feed on living matter.

② Oxygen.
The presence or absence of oxygen will influence the survival of the microbe.
a) Aerobic: needs oxygen
b) Anaerobic: doesn't need oxygen
c) Facultative: grows with or without oxygen

③ Temperature

All microbes have an ideal temperature for growth which encourage cells to multiply. The 3 main groups:

a) Psychophiles : prefer low temp (-5°C to 20°C)
b) Mesophiles : most survive in this category (20°C to 45°C)
c) Thermophiles : prefer temp above 45°C.

④ Moisture | Water Activity

- Liquids or moisture are necessary for all microbes to survive & grow
- Low moisture content can slow down growth.

⑤ Correct pH

pH is calculated on a scale from 0 to 14 → 0 = acidic
7 = neutral
14 = alkaline

most microbes prefer 7 - neutral but all microbes have their own preferred pH. for growth.

⑥ Time

Micro organisms need time to grow
But as time goes on they compete for other conditions above

How do micro-organisms feed & multiply & contaminate food?

- They secrete enzymes into their source of food
- The enzymes break down the food into simple soluble compounds
- These are then absorbed through the cell wall of the microbe providing nourishment (food)

1. Fungi

- can be divided into moulds, yeast and larger fungi
- do not contain chlorophyll so they cannot produce their own food
- most are saprophytic eg mucor on bread
  but can be parasitic eg athlete's foot on humans.

Classification of fungi:

1. moulds
2. Large fungi
3. Yeasts.

1. Moulds

- multicellular structures - can be seen on foodstuffs.
- can contaminate many food stuffs eg jam
- usually, the surface of the food is only contaminated (when mycotoxins are produced).

Structure of Moulds:

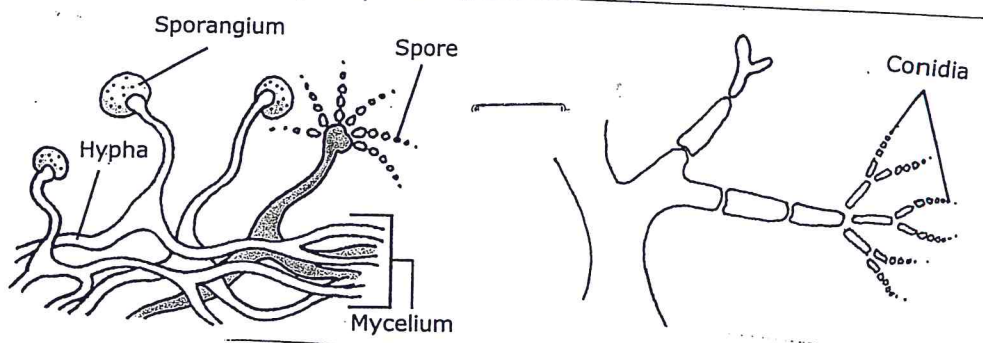
- basic unit of all moulds is a spore - it is a single cell.
- a spore locates a suitable place to grow ie food
- If conditions are favourable, it produces a thread-like filament called a hypha.
- The hypha grows down into the food source and absorbs nutrients
- The hypha continues to grow, branching out into many hyphae called a mycelium
- As the hyphae continue to grow, they grow upwards.
- They release enzymes which breakdown the nutrients and absorb them.

Reproduction of Moulds

- can be Asexual or Sexual.

(i) Asexual Reproduction of mould

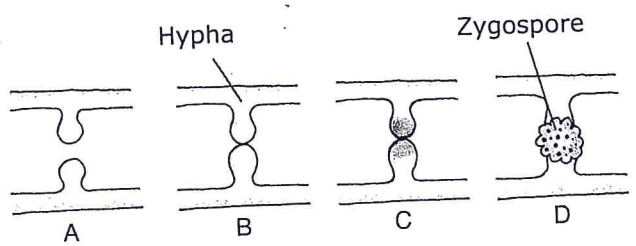
- takes place when the mycelium is well established and condition are favourable.
- hyphae continue to grow upwards
- the top of the hyphae enlarge to produce a sporangium (round sh or a conidia (chain of spores).



- When ripe a sporangium bursts and releases spores
- A conidia breaks away from the hyphae and releases spores They can be carried by air or water.
- When spores find a suitable medium (food) the cycle starts again.

(ii) Sexual Reproduction of moulds.

- occurs when conditions are unsuitable for the germination of a spore.
- Two hyphae grow towards each other.
- The two hyphae meet and fuse together
- The dividing wall between the two hyphae disappears and a zygospore develops.
- The zygospore produces and stores spores. It can survive a long time.
- It has a thick wall and protects the spores until suitable conditions appear.
- When conditions are right, spores germinate, hyphae grow and extend. Spores are released.



SEXUAL REPRODUCTION

Classification of moulds

Classification	Examples	Description	Grows on
Phycomycetes • Favour optimum temperature range of 30°C–40°C. • Mainly non-septae.	Mucor	• Saprophytic mould. • Reproduces sexually and asexually. • White hyphae. • Grey sporangia.	• Bread, other starchy foods, e.g. grain • Meat • Soil
• Reproduce sexually and asexually. • Hyphae develop sporangia.	Rhizopus	• Saprophytic mould. • Reproduces asexually. • Fluffy white mycelium. • Black pin-head sporangia.	• Bread • Vegetables (soft rot) • Berries, fruits (soft rot) • Soil
Ascomycetes • Favour lower optimum temperatures of 20°C–25°C. • Most have septae. • Reproduce asexually only. • Hyphae develop conidia.	Penicillium	• Saprophytic mould. • Green-blue mould with a powdery texture. • Used in the production of blue-veined cheese. • Used in the production of antibiotics.	• Cheese • Bread • Fruit
	Aspergillis	• Saprophytic mould. • Occurs as black mould and greenish mould.	• Raw sugar • Dried fruit, • Fruit, vegetables (black-rot) • Grain

Growing conditions favoured by moulds:

1. Food: most are saprophytic
2. Oxygen: most are aerobic
3. Temperature: usually mesophile (below 15° inactivates, above 75°C kills
4. Moisture: prefer moist conditions
5. pH: most like acidic pH 4–6
6. Time: time is necessary for multiplication.

2. Large Fungi

- generally edible eg mushrooms
- visible to naked eye
- include many varieties – Agaricus campestris (field mushroom)
  - Truffles – a delicacy, grown underground & located by special pigs sniffing the smell

Reproduction of Basidiomycetes:

- begin as spores
- Spore produces hyphae in favourable conditions. As hyphae grow they develop mycelium.
- The hyphae are packed close together and grow upwards from the mycelium.
- A tightly closed cap forms at the top.
- This increases in size and opens as the mushroom develops.
- Gills form underneath the cap. Between the gills are basidia which form spores.
- When the mushroom is fully ripe it releases the spores
- If the spores find a suitable medium, the cycle begins again.

3. Yeasts. (Saccharomycetes)

- Unicellular - single cell
- found in the air, soil and on the surface of fruit.
- Can spoil fruit, jam, wine and meat.
- Some foodstuffs rely on yeast for their production eg bread, beer and vinegar.

Structure of Yeast.

- usually oval in shape
- have a thin outer wall
- Inside they contain cytoplasm which contains a nucleus and vacuoles.

Reproduction of Yeast:

- Asexual reproduction by budding
- The yeast cell develops a bulge. The nucleus moves towards the bulge (bud). The nucleus splits in two.
- A wall develops which separates the original yeast cell and the bud. The bud then moves away from the original cell.

- In optimum growing conditions, a chain of yeast cells may develop. A bulge appears on the bud, before it has fully separated from the original cell.

Growing conditions favoured by yeasts:

1. Food: Carbohydrate based food eg sugar
2. Oxygen: facultative
3. Temperature: favour 25°-30°C (above 60°C they are destroyed)
4. Moisture: prefer moist conditions
5. pH: prefer acidic conditions pH 4-6
6. Time: need time to grow & multiply

Advantages of Fungi:

→ Moulds - used in production of cheese eg Stilton
- used in production of antibiotics eg penicillin

→ Yeast - used for food supplements as high in vitamin B
- used in production of bread and brewing (beer)

→ Other - responsible for decomposing organic matter
- edible & may be regarded as delicacies eg truffles
- used in production of alternative protein foods eg Quorn

Disadvantages of fungi:

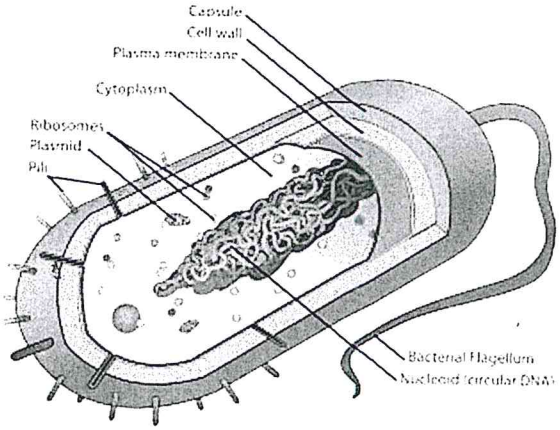
- Some are poisonous if ingested (swallowed) eg Amanita
- Some cause human disease eg Athlete's foot
- May cause food spoilage
- May be responsible for some plant diseases eg potato blight

BACTERIA

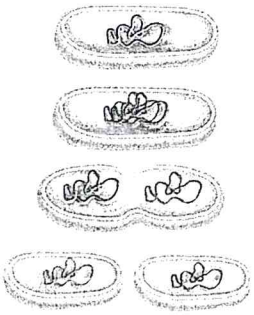
- Unicellular - single celled
- Can be saprophytic or parasitic
- Ubiquitous – are found almost everywhere – water, soil, air, humans, animals etc
- Can be pathogenic (disease causing) or non-pathogenic

Structure of Bacteria

- **Rigid cell wall** – gives it structure
- Inside the cell wall is a **membrane**
  – it encloses a colourless liquid called **cytoplasm**
- The cytoplasm contains **nuclear material**, **ribosomes** (makes protein) and **food** stores
- Some bacteria have a thick **protective capsule** which surrounds the cell wall
- Some also have hair-like structures called **flagellae** which assist in the movement of the bacteria



Reproduction of Bacteria



- Bacteria reproduce by **Binary Fission** – they divide in two
- This is a method of Asexual reproduction
- In optimum conditions, the bacteria can multiply every 20 minutes (resulting in over 1 million bacteria cells in 5 hours)
- The nuclear material divides in two and so on
- A cell wall develops which separates the two cells
- These two cells produce four cells in 20 mins and so on
- Large groups of bacteria are called 'colonies'
- Rapid growth causes overcrowding and competition for food, oxygen, moisture etc
- Waste toxins may build up preventing growth and causing death of bacteria

Growth Phase of Bacteria:

1. Lag Phase: getting used to surroundings
2. Log Phase: begin to grow and multiply
3. Stationary Phase: overcrowding & competition for nutrients
4. Decline phase: build-up of waste products kills bacteria

Spore formation in Bacteria:

- If conditions are not suitable for bacteria to grow, some bacteria may produce spores eg Bacilli and Clostridia
- Spores produced by bacteria are called 'endospores'
- They are resistant to extreme heat, cold and certain chemicals eg disinfectants
- Ordinary cooking temperatures do not destroy spores (121°C moist heat for 15 mins, or 150°C dry heat for one hour will destroy them)
- Can survive for months or years

1. The endospore develops in the bacteria cell
2. It continues to grow a strong protein wall
3. The parent cell disintegrates
4. The spore is released and will germinate (grow) when conditions are suitable

Conditions necessary for bacteria growth:

Food: can be saprophytic or parasitic
Oxygen: can be aerobic, anaerobic or facultative
Temperature: most are mesophiles, but can be psychophiles or thermophiles
Moisture: need liquid to grow
pH: most bacteria prefer neutral (7)
Time: in ideal conditions – bacteria can double in size in 20 mins

Classification of Bacteria

Bacteria can be classed by gram staining or by shape

Classification by staining:

1. Bacteria are placed on an agar plate
2. Crystal violet dye is poured over the bacteria (turns blue)
3. Iodine is then poured over it (blue/black)
4. Finally alcohol is poured over the bacteria and the results are observed.

The bacteria are classed according to the colour they turn:

	Gram Positive	Gram Negative
Colour	Blue/purple	Pink
Structure	Cell wall has one layer	Cell wall has two layers
Mobility	No flagellae	Flagellae
Reproduction	Produces spores	Doesn't produce spores
Examples	Streptococci	E. Coli, Salmonella

Classification by shape:

1. **Cocci – sphere shape**

Cocci:	Single	Meningitis
Diplococci:	Pair	Pneumonia
Streptococci:	Chains	Tonsillitis
Staphylococci:	Clusters	Food poisoning: Staphylococcus aureus

2. **Bacillus – rod shape**

Bacilli:	Individual rods	Salmonella
Clostridia:	Chain-like	Clostridium Botulium

3. **Spiralla – spiral, long & coiled**

Spiralla:	spiral, long & coiled	STIs eg syphilis

4. **Vibrio – short, curved & rod shaped**

Vibrio:	shaped like a comma	Cholera

Advantages of Bacteria	Disadvantages of Bacteria
- used in the production of cheese, yoghurt etc - involved in the breakdown of waste matter - produce vit B & K in intestine - used in production of food supplements	- can contaminate food and cause food poisoning - can cause other human diseases eg tonsillitis - cause disease in animals eg brucellosis in cows - food spoilage eg souring of milk - they damage some plants eg apple scab - tooth decay