



Monera

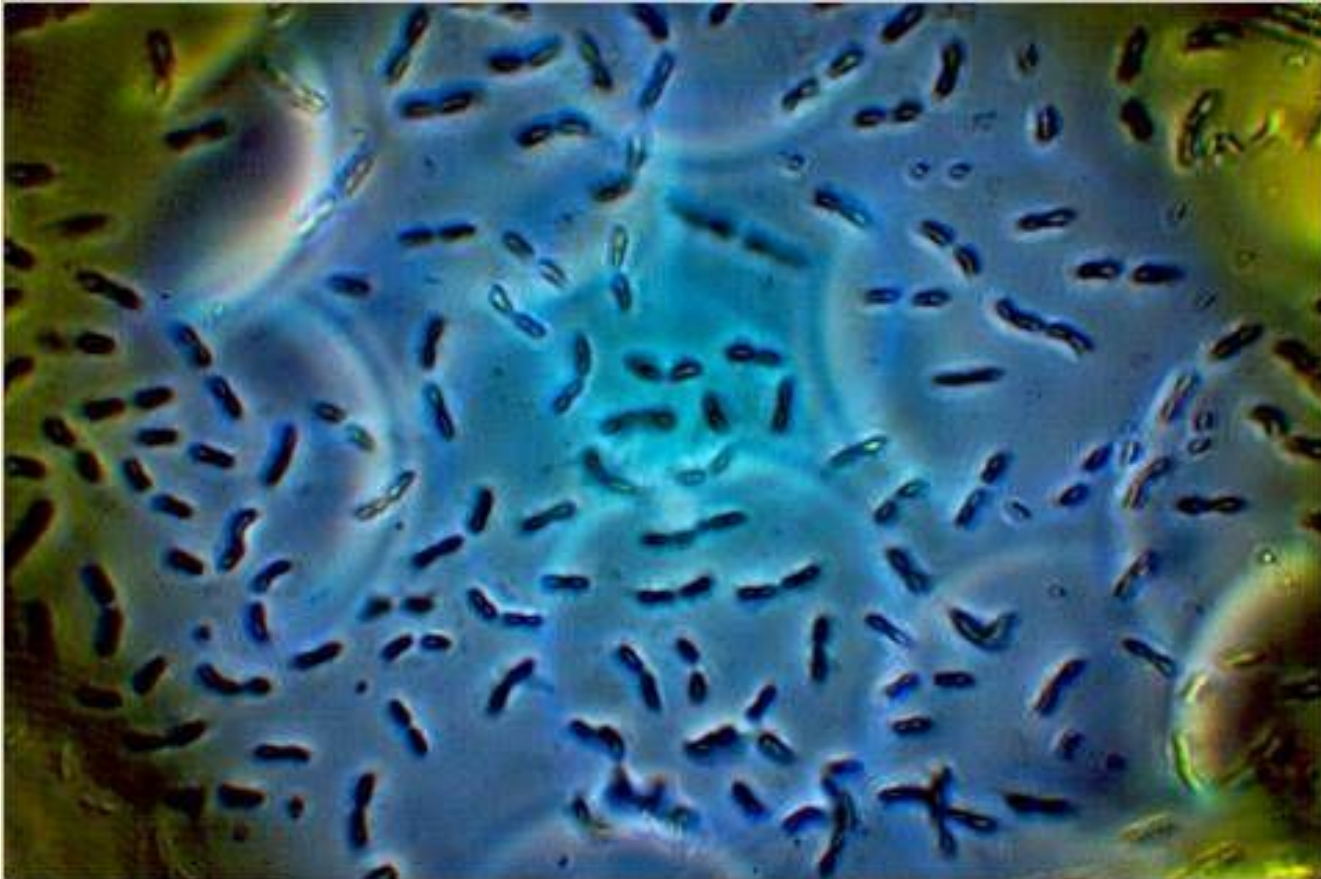


e.g. Bacteria

Learning Objectives

- Name 3 types of bacterial cell
- Explain reproduction of bacteria
- Explain nutrition of bacteria
- State the factors affecting growth of micro-organisms
- Define the term pathogenic
- Define the term antibiotics
- State the role of antibiotics
- Outline the potential abuse of antibiotics
- Outline the economic importance of bacteria
- Name 2 Beneficial & 2 Harmful bacteria

Bacteria in pond water



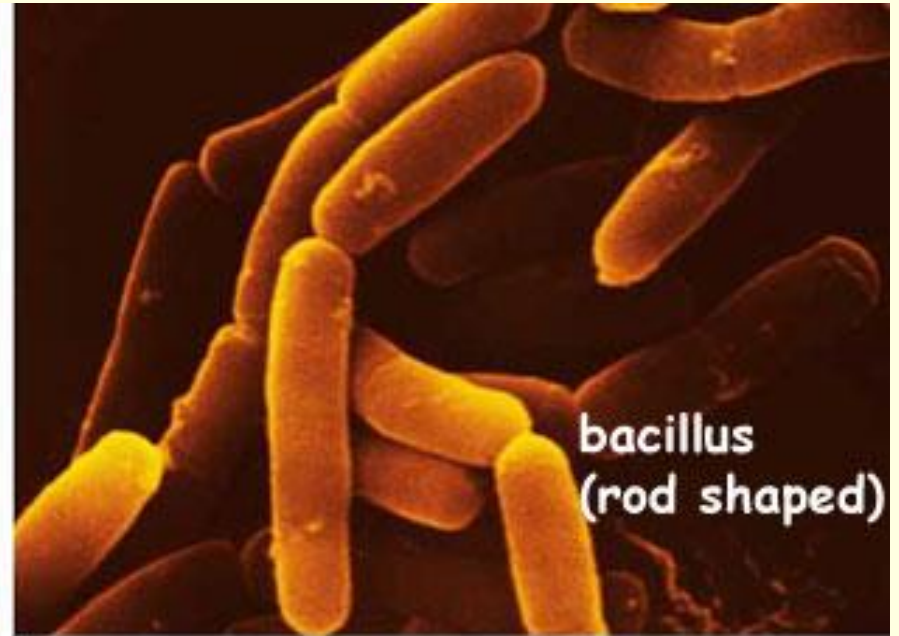
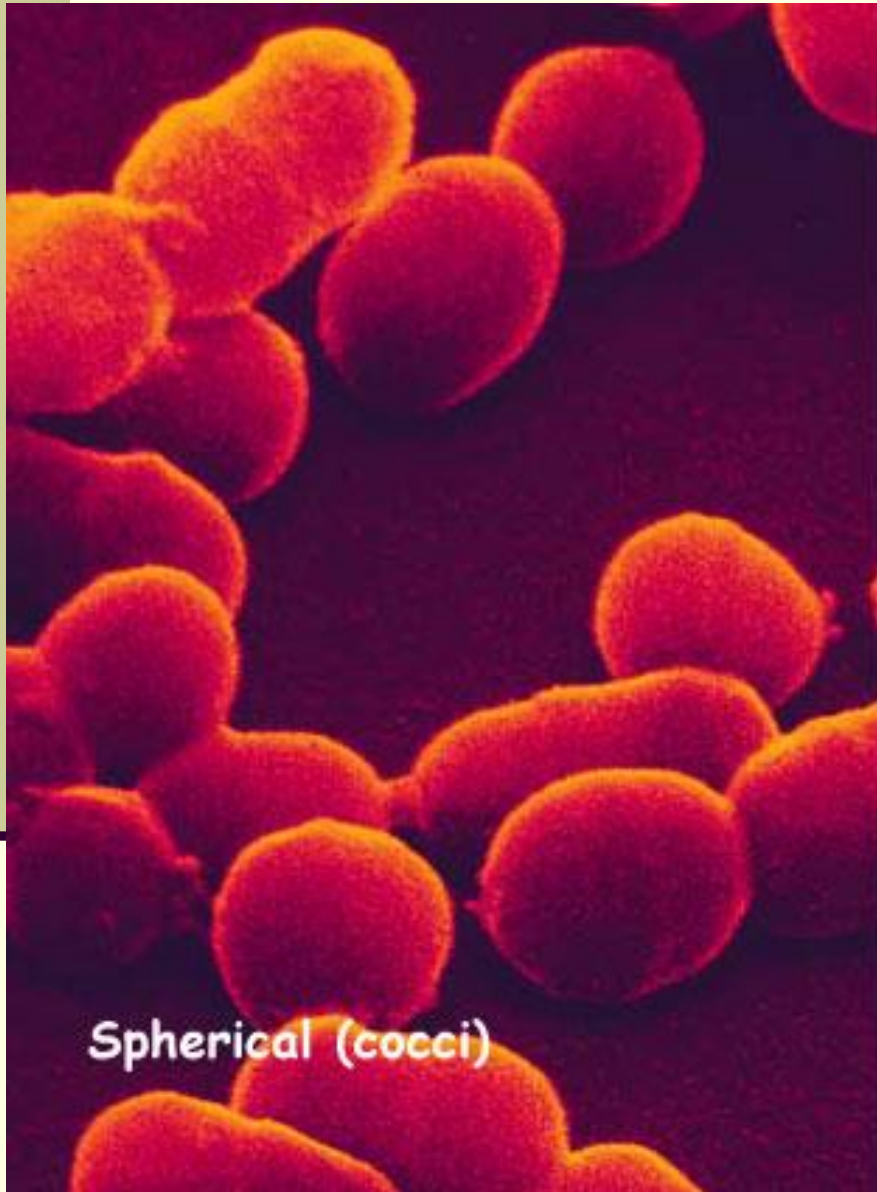
Bacteria on apple



Bacteria

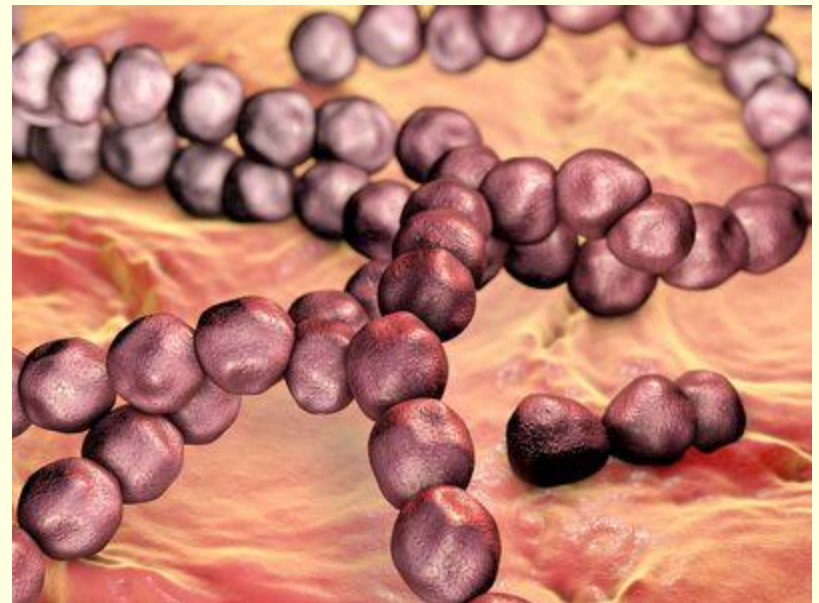
- Bacteria belong to the kingdom Monera. They are unicellular organisms
- Also known as prokaryotes as they have no membrane bound nucleus or membrane bound cell organelles
- They are classified according to three shapes
 1. **Spherical (cocci)**
 2. **Rod (bacillus)**
 3. **Spiral (spirillum)**

Bacterial Shapes



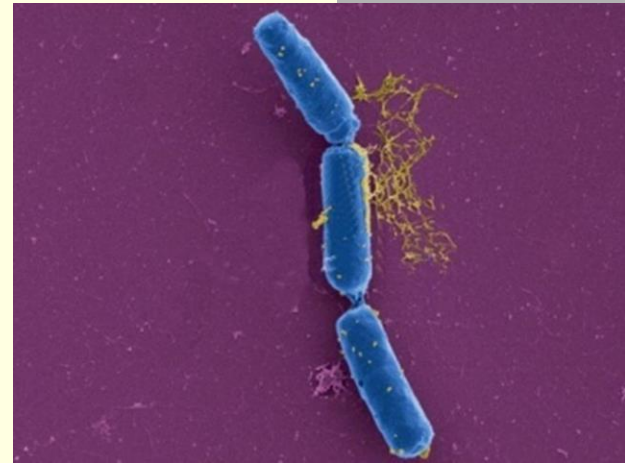
Spherical (cocci)

- *E.g. Streptococcus (Group A)*
- Causes Step Throat



Rod (bacillus)

- *E.g. Bacillus anthracis*
- Cause of anthrax

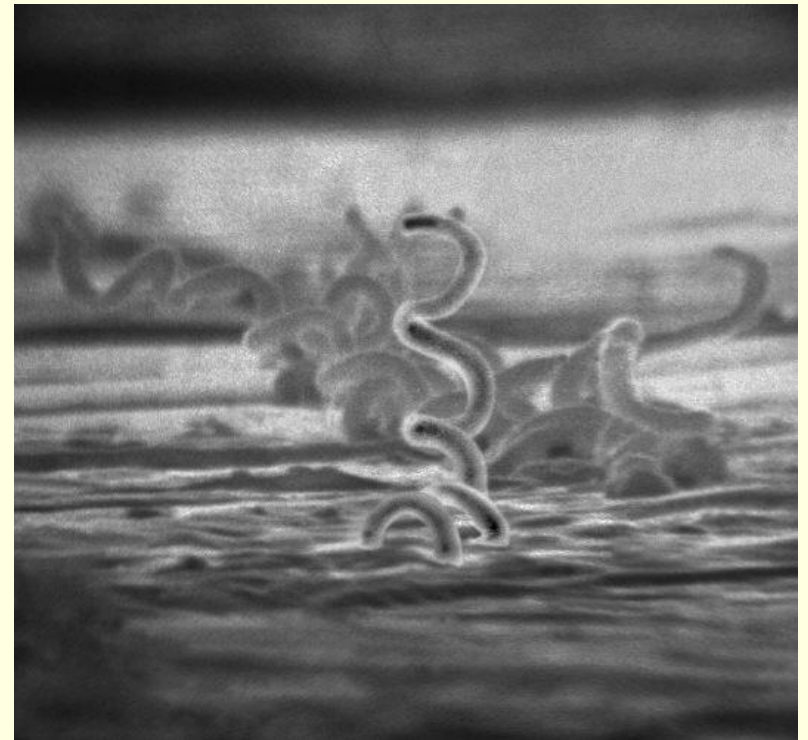


- *Escherichia coli (E.coli)*
- Live in human gut



Spirillum (spiral)

- *E.g. Treponema pallidum*
- *Causes syphilis*



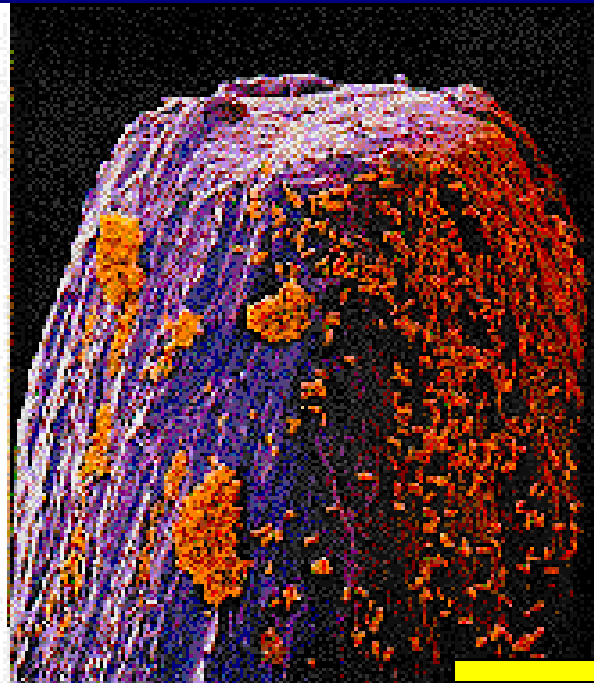
Bacterial size

Size of Bacteria

Bacillus cells on the tip of a pin.



100 um



20 um

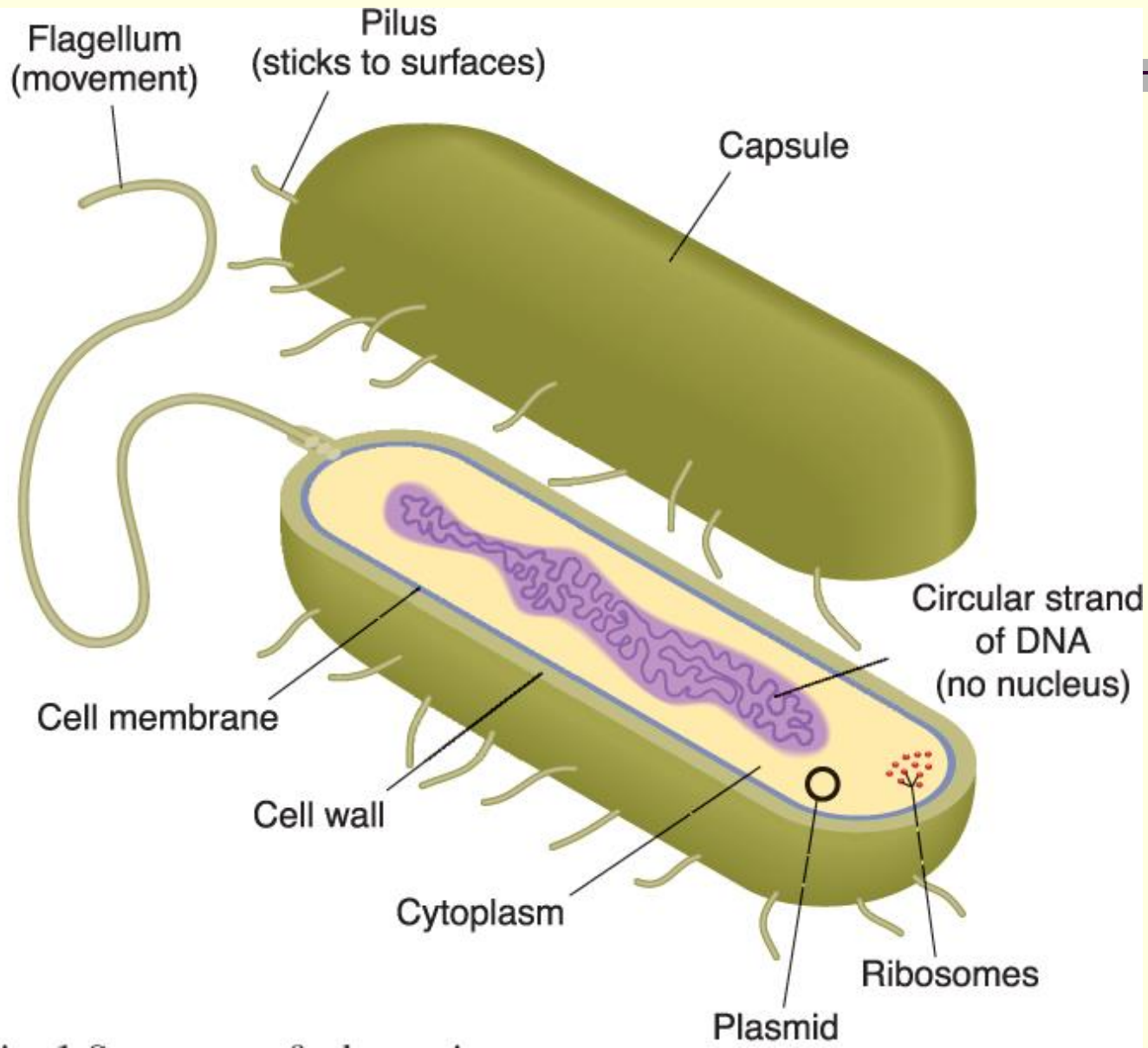


10 um

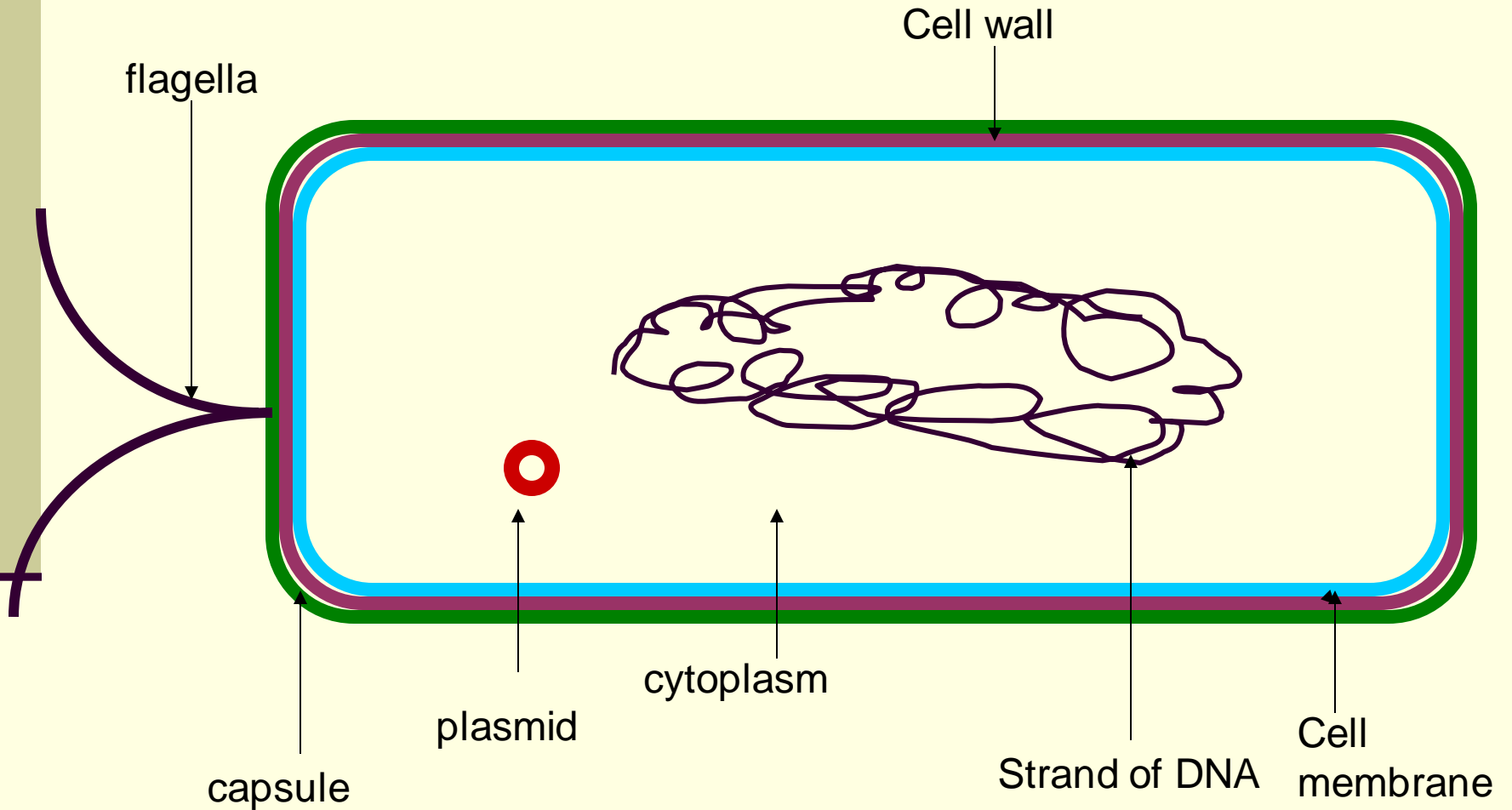
Learning Check

- To what kingdom do Bacteria belong?
- How are they classified?
- What are the three bacterial shapes?

Bacterial Structure



Bacterial Structure



Cell Parts & Function

- Cell wall - shape & structure
- Cytoplasm - contains ribosomes and storage granules but no mitochondria or chloroplasts
- Nuclear material -single chromosome of DNA
- Capsule* - protection
- Flagella* - movement
- Plasmid* -circular piece of DNA containing a few genes for drug resistance

* Sometimes present.

Prokaryotic Cell Structure

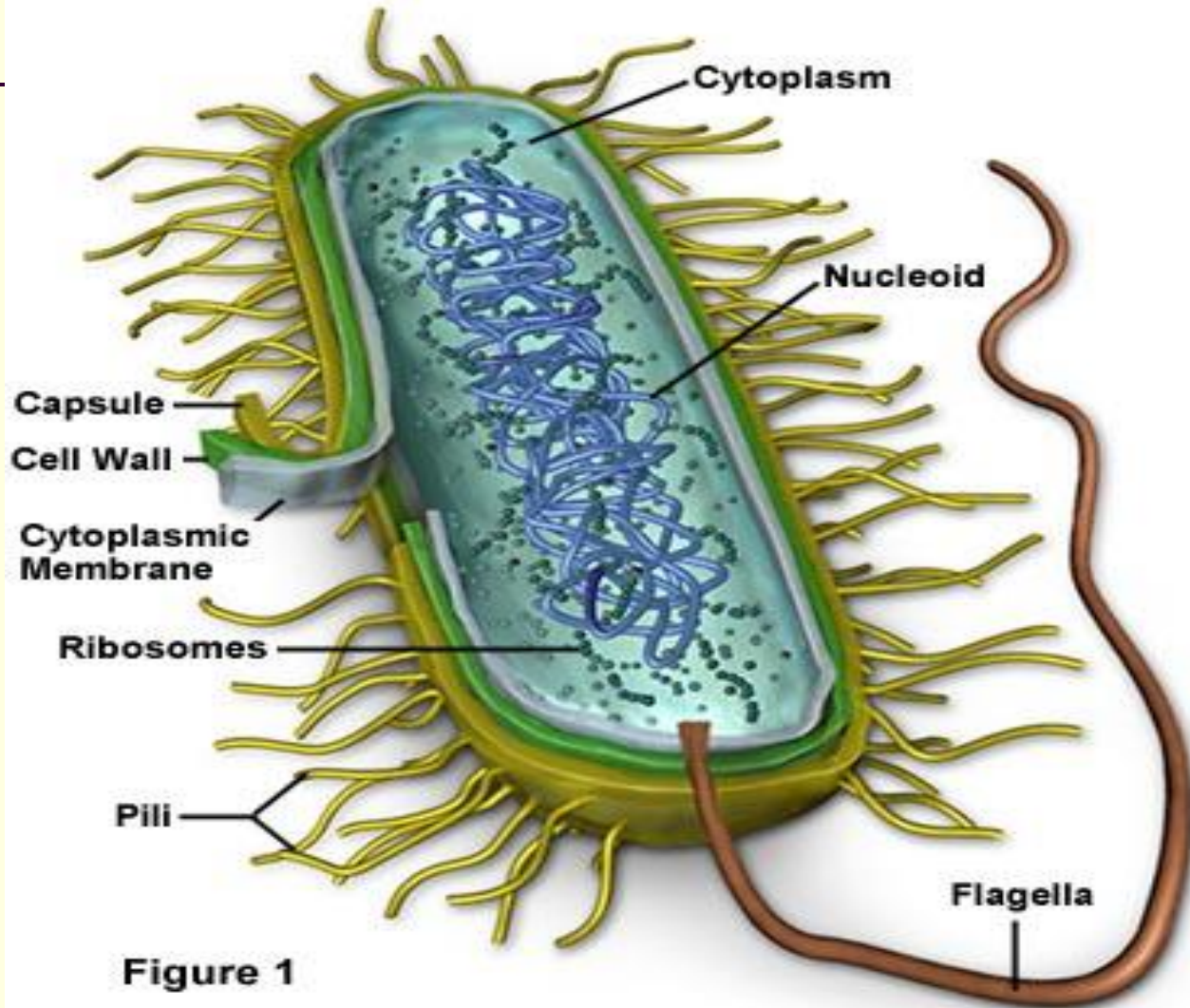


Figure 1

Learning Check

- Name the components of a bacterial cell
- Give the function of the following parts:
 - Cell Wall
 - Cytoplasm
 - Capsule
 - Flagella
 - Plasmid



Bacterial Reproduction

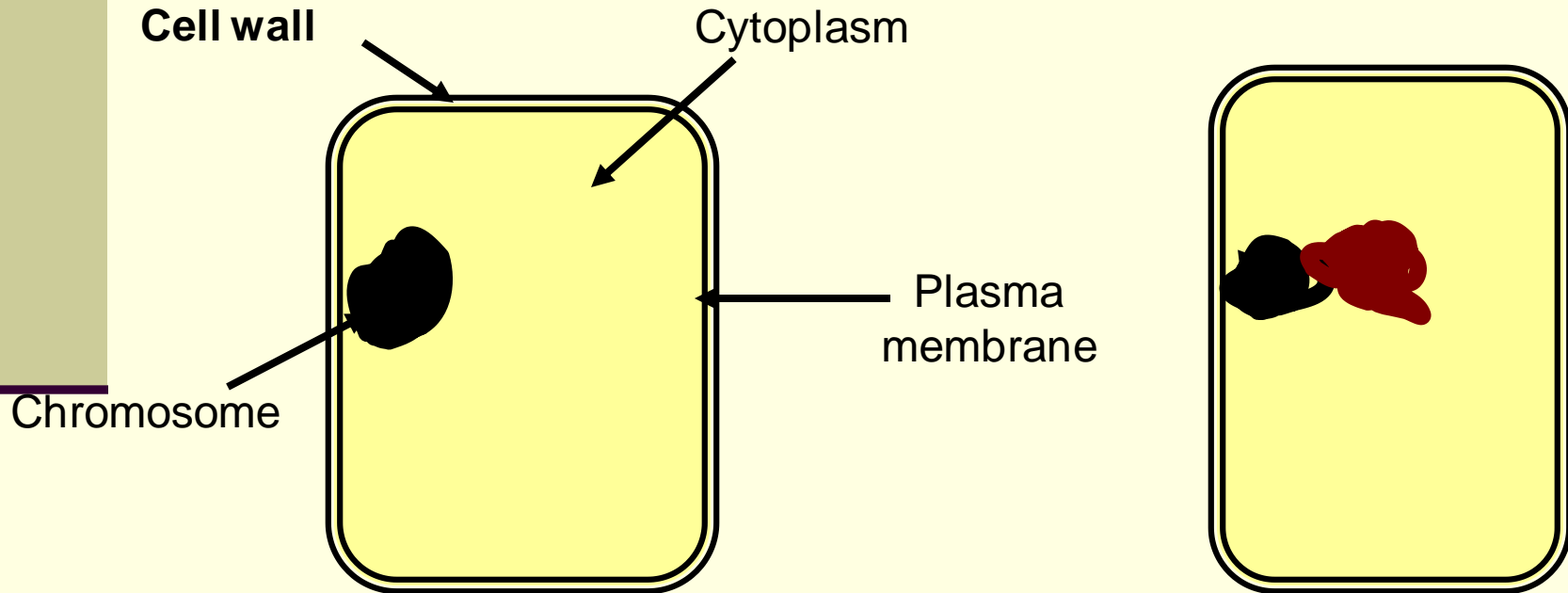


Bacterial reproduction

- Bacteria reproduce **asexually**
- The method used by a bacteria to reproduce is called **Binary Fission**

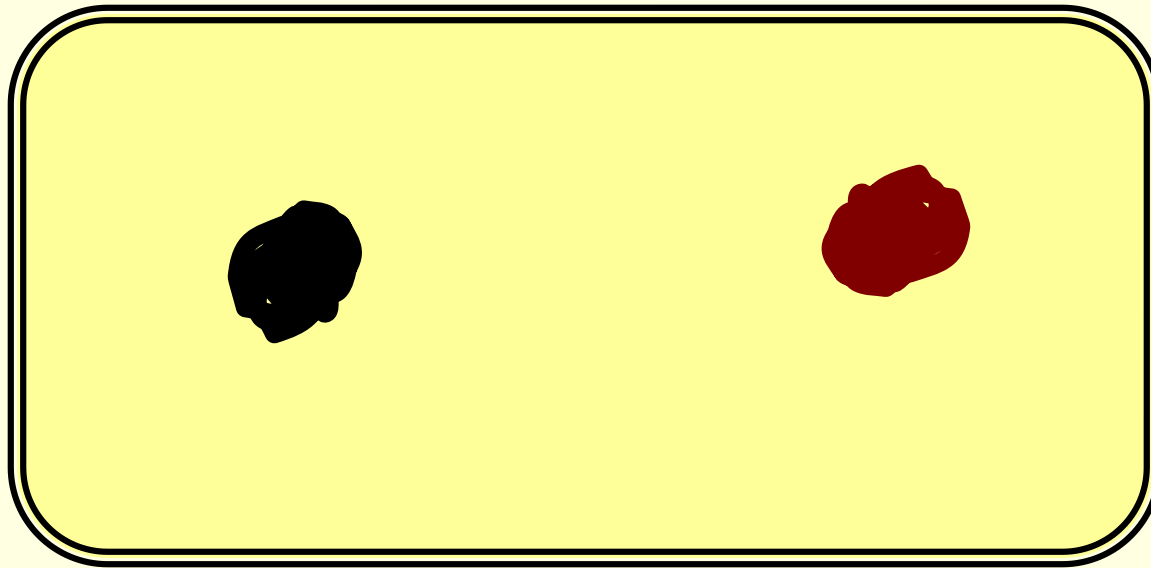
Binary Fission

The chromosome attaches to the plasma membrane and the DNA is replicated



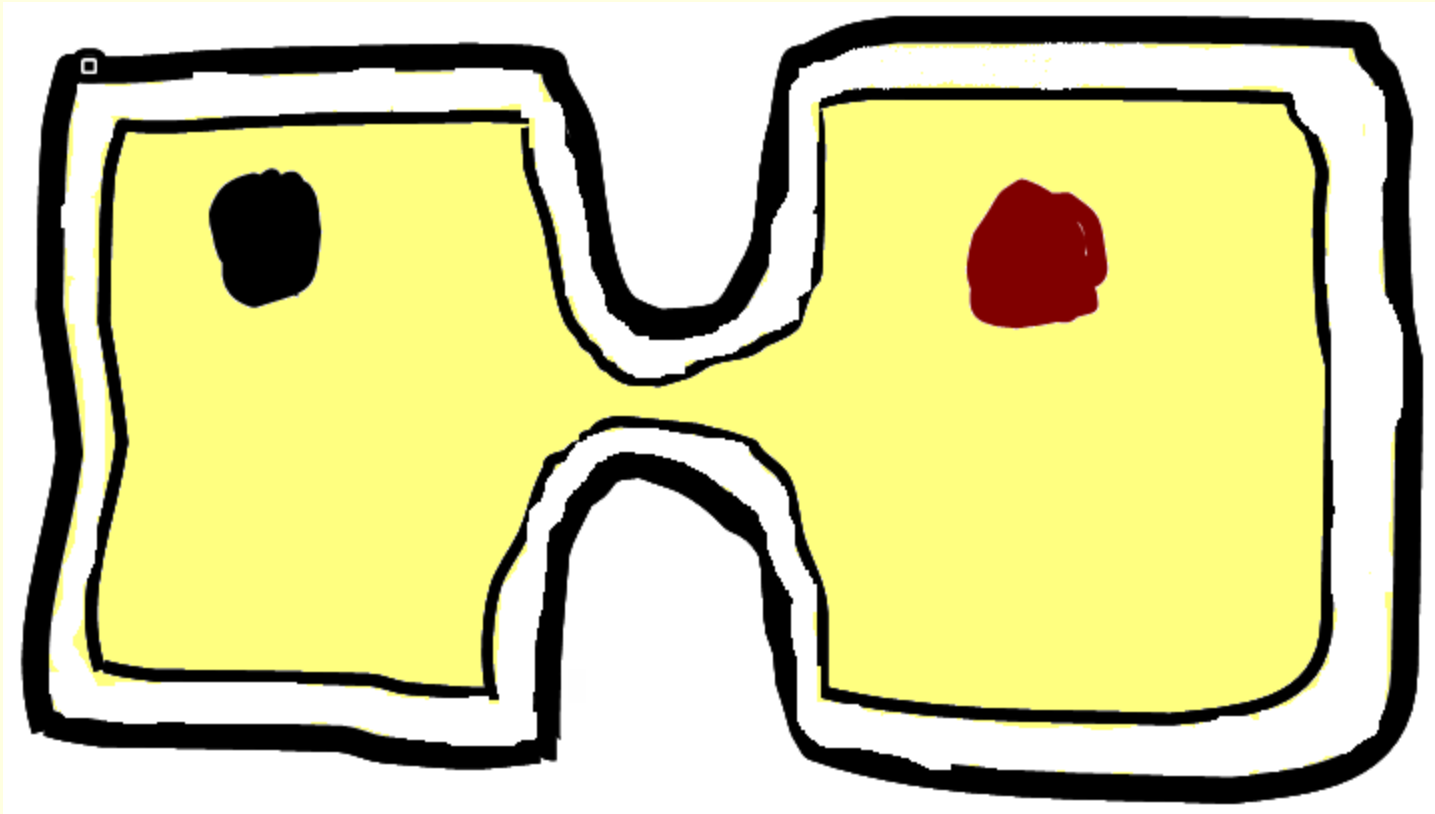
Binary Fission

The cell elongates and the two chromosomes separate



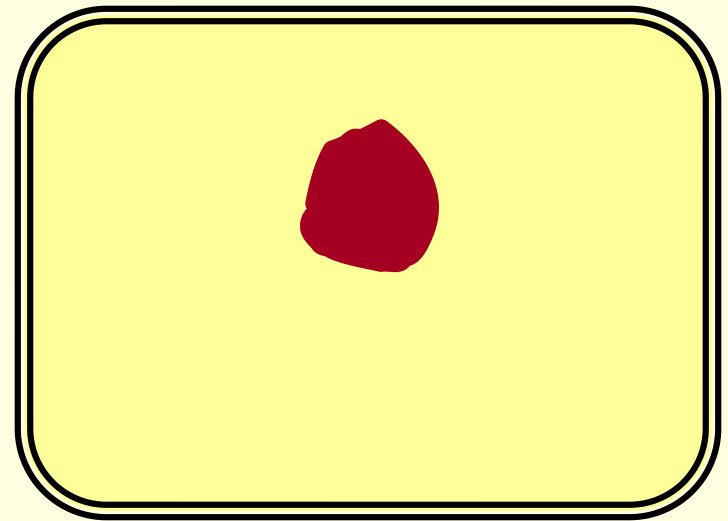
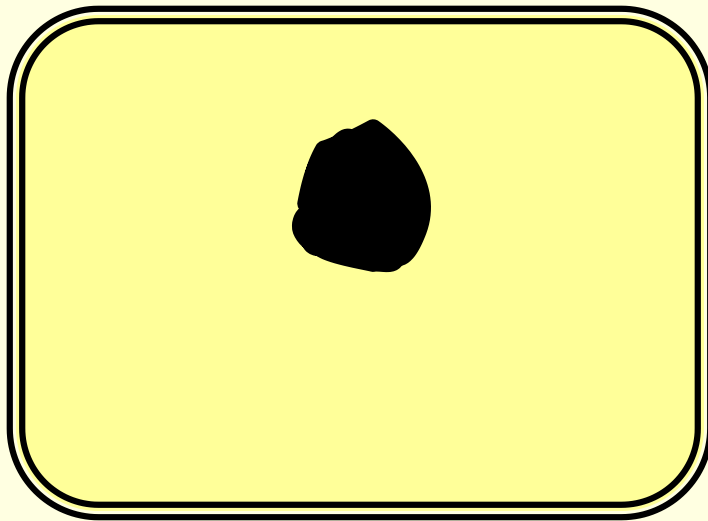
Binary Fission

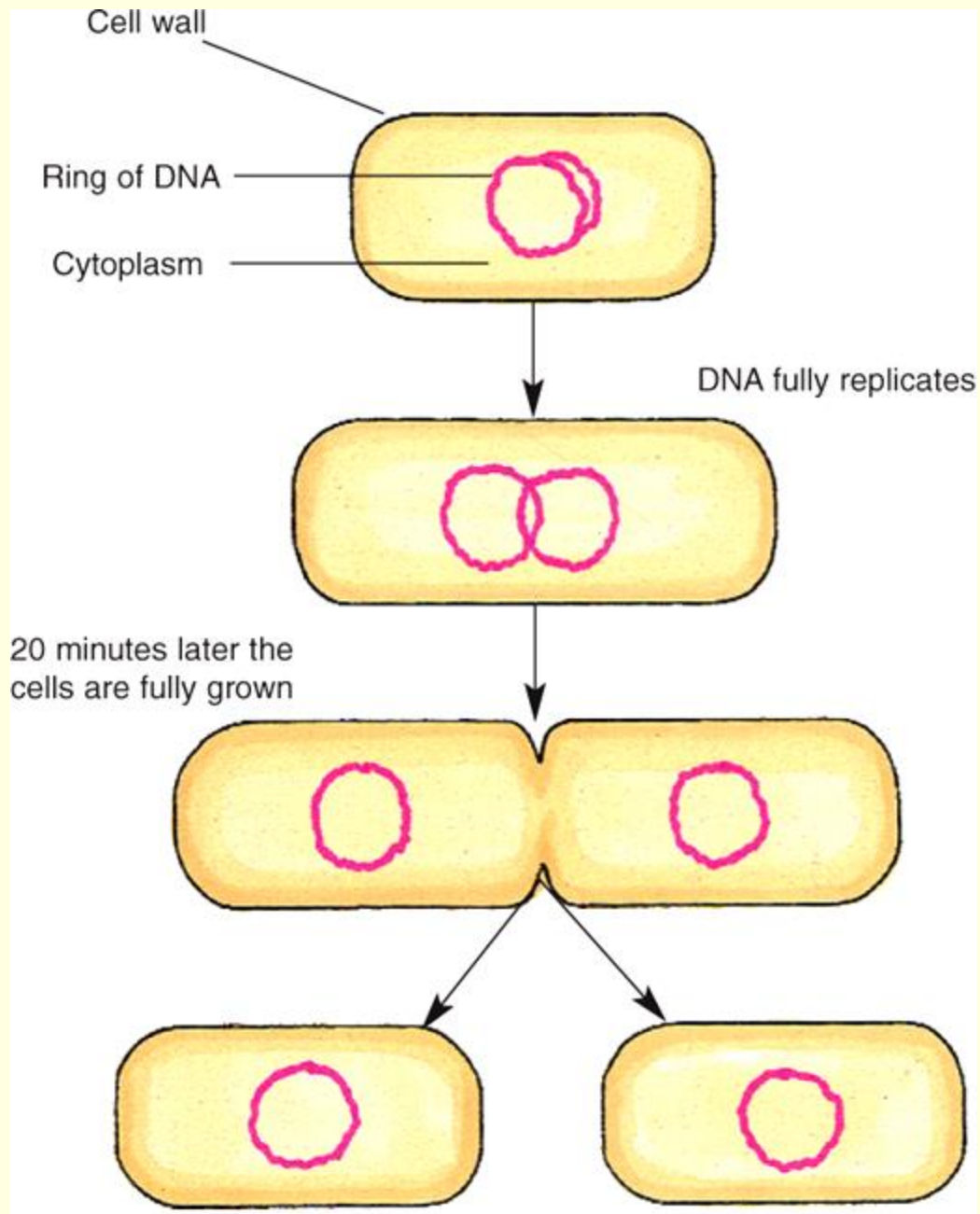
The cell wall grows to divide the cell in two



Binary Fission

Two identical daughter cells are formed





Bacterial Reproduction

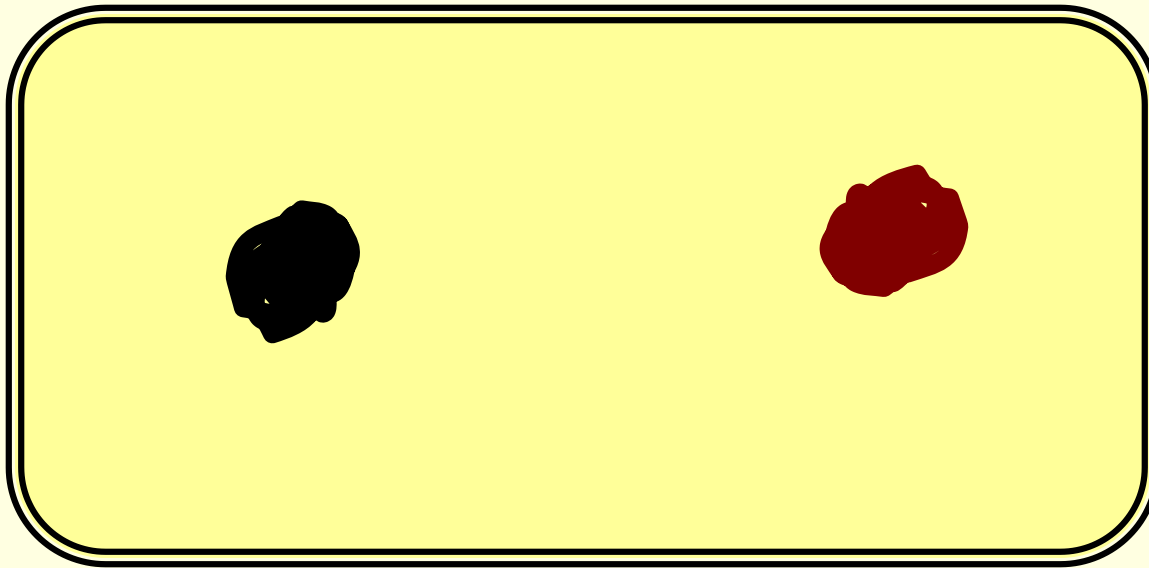
- Bacteria reproduce asexually - their offspring are genetically identical
- As there is little recombination of genetic material in this method of reproduction one would expect that bacteria would be slow to evolve
- Bacteria has a very short lifecycle (some can reproduce every 20 minutes).
- New mutations can spread very quickly
- This is how bacteria evolve resistance to new antibiotics

Endospore formation

- Some bacteria can withstand unfavourable conditions by producing endospores

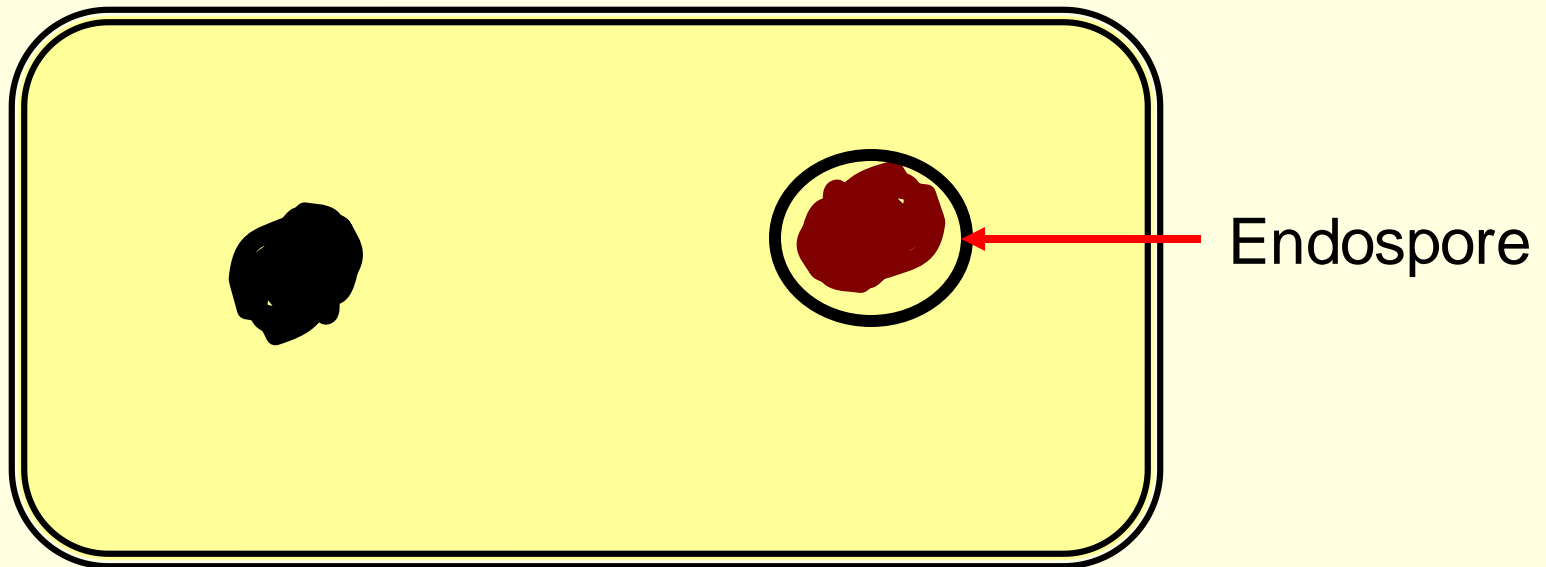
Endospore formation

These are formed when the bacterial chromosome replicates



Endospore formation

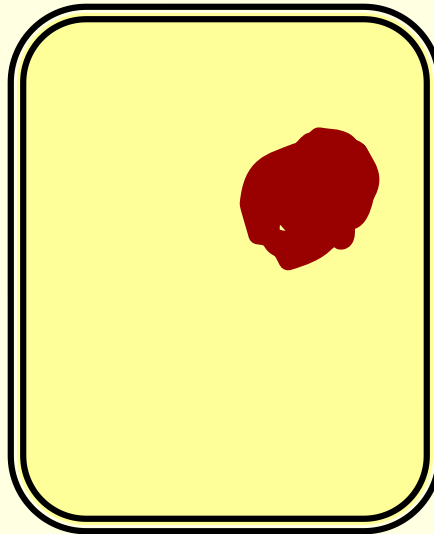
- One of the new strands becomes enclosed in a tough-walled capsule called an endospore



- The parent cell then breaks down and the endospore remains dormant

Endospore formation

- When conditions are favourable the spores absorb water, break their walls and reproduce by binary fission



Learning Check

- How do bacteria reproduce?
- What is binary fission?
- What is the purpose of an endospore?
- How are endospores formed?



Bacterial Nutrition



Autotrophic and Heterotrophic

- **Autotrophic** – organisms which make their own food
- **Heterotrophic** – organisms which take in food made by other organisms

Autotrophic Bacteria

Photosynthetic bacteria

- Use light energy to make food
- E.g. purple sulphur bacteria



Autotrophic Bacteria

Chemosynthetic bacteria

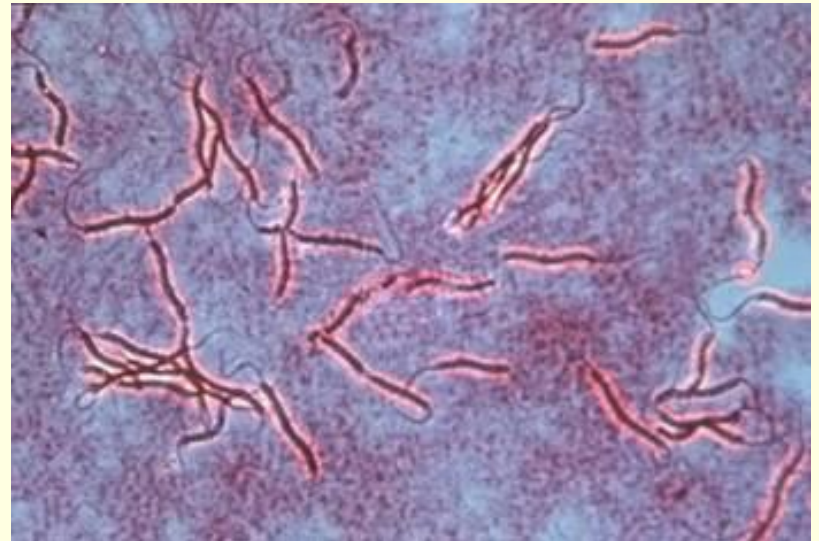
- Use energy from chemical reactions to make food
- E.g. Nitrifying bacteria that convert ammonia to nitrates in the nitrogen cycle



Heterotrophic Bacteria

Saprophytic Bacteria

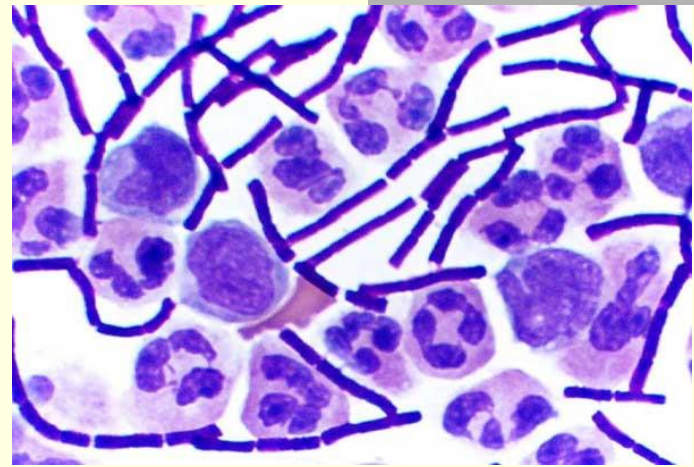
- Live off dead organic matter
- E.g. bacteria of decay in the soil



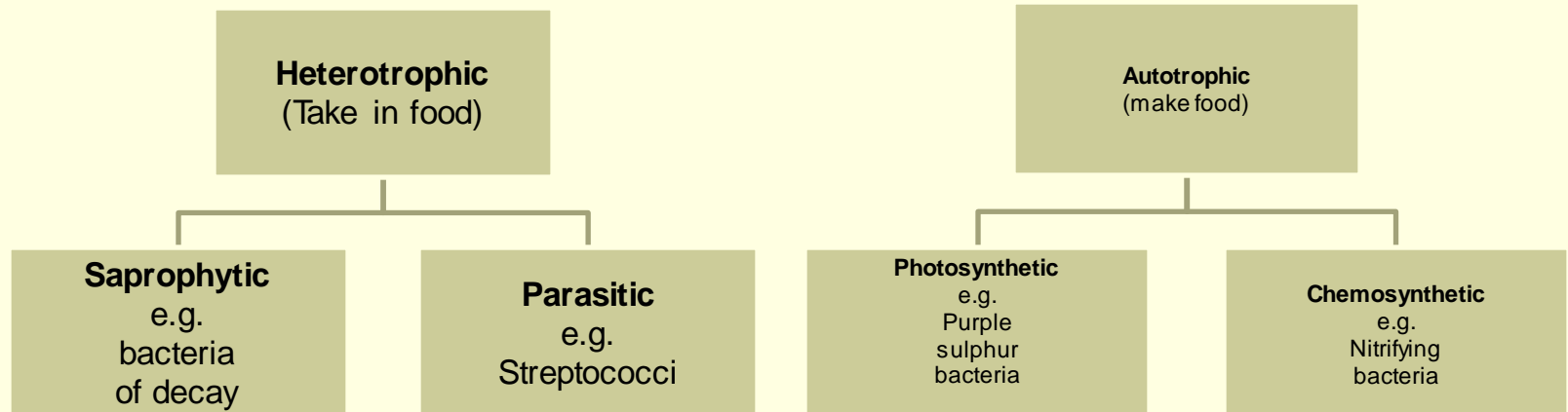
Heterotrophic Bacteria

Parasitic Bacteria

- Take food from live host
- Some cause diseases
- *E.g. Bacillus anthracis*
causes anthrax



Bacterial Nutrition



Learning check

- Name the three different types of bacteria.
- By what method do bacteria reproduce.
- Describe the steps involved in this method of reproduction.
- Bearing in mind the mode of reproduction involved how do bacteria develop resistance to antibiotics?
- Name the main categories of bacteria with regard to their nutritional methods.

Factors affecting the growth of bacteria

- For the maximum growth rate bacteria must have access to a food source and the conditions of their environment must be monitored closely



Factors affecting the growth of bacteria

- Too much or too little of any of the following factors will slow down the growth of bacteria:
 - Temperature (20-30)
 - Oxygen concentration
 - pH
 - External solute concentration
 - Pressure



Temperature

- Most bacteria grow well between 20°C and 30°C.
- Some can tolerate much higher temperatures without their enzymes becoming denatured.
- Low temperatures slow down the rate of reaction of enzymes resulting in slower growth.

pH

- If a bacterium is placed in an unsuitable pH its enzymes will become denatured.

1. Temperature

- Most bacteria grow well between 20°C and 30°C.
- Some can tolerate much higher temperatures without their enzymes becoming denatured.
- Low temperatures slow down the rate of reaction of enzymes resulting in slower growth

2. pH

- If a bacterium is placed in an unsuitable pH its enzymes will become denatured

3. Oxygen concentration

- **Aerobic bacteria** require oxygen for respiration e.g. *Streptococcus*
- This is why oxygen is sometimes bubbled through bioreactors



3. Oxygen concentration

- **Anaerobic bacteria** do not require oxygen to respire
 - **Facultative anaerobes** can respire with or without oxygen e.g. *E.Coli* (found in intestines)
 - **Obligate anaerobes** can only respire in the absence of oxygen e.g. *Clostridium tetani* (causes tetanus)



4. External Solute concentration

- Bacteria can gain or lose water by osmosis
- If the external solute concentration is
 - higher than the bacterial cytoplasm water will move out of the bacteria (Dehydration)
 - Food preservation techniques are based on this

4. External Solute concentration

- Bacteria can gain or lose water by osmosis
- If the external solute concentration is
 - lower than the bacterial cytoplasm solute concentration water will enter the bacteria
 - Cell wall will prevent bursting in most cases

5. Pressure

- The growth of most bacteria is inhibited by high pressures.
- Some bacteria can withstand high pressures. Pressure tolerant bacteria for use in bioreactors can be formed by genetic engineering techniques.

Learning Check

- Describe how the following affect bacterial growth
 - Temperature
 - pH
 - Oxygen concentration
 - External Solute concentration
 - Pressure

Economic importance of bacteria

Beneficial bacteria

- Bacteria such as *Lactobacillus* are used to convert milk to products such as cheese and yoghurt
- Genetically modified bacteria e.g. *E. Coli* are used to make products such as insulin, enzymes, drugs, food flavourings and vitamins

Economic importance of bacteria

Harmful bacteria

- Micro-organisms that cause disease are called **pathogens**
- *E.g. Bacillus anthracis* causes anthrax in humans
- If they enter the body through a wound they can multiply and effect the nerves and activity of muscles
- Other bacterial diseases include tuberculosis, typhoid, cholera, diphtheria and brucellosis

Beneficial and harmful bacteria

BENEFICIAL

- Lactobacillus converts milk to yoghurt and cheese
- Antibiotics can be formed by some microorganisms
- Bacteria in the colon help produce vitamins
- G.M.O.'s are used to make insulin and other useful compounds
- Bacteria are active in the Carbon and Nitrogen Cycles

HARMFUL

- Pathogenic Bacteria can cause diseases in humans and animals.
- Pathogenic Bacteria can cause diseases in plants.
- Bacteria can cause food spoilage
- Bacteria can cause tooth decay.



Antibiotics

Antibiotics

- Antibiotics are substances produced by microorganisms that stop the growth of, or kill, other microorganisms without damaging human tissue



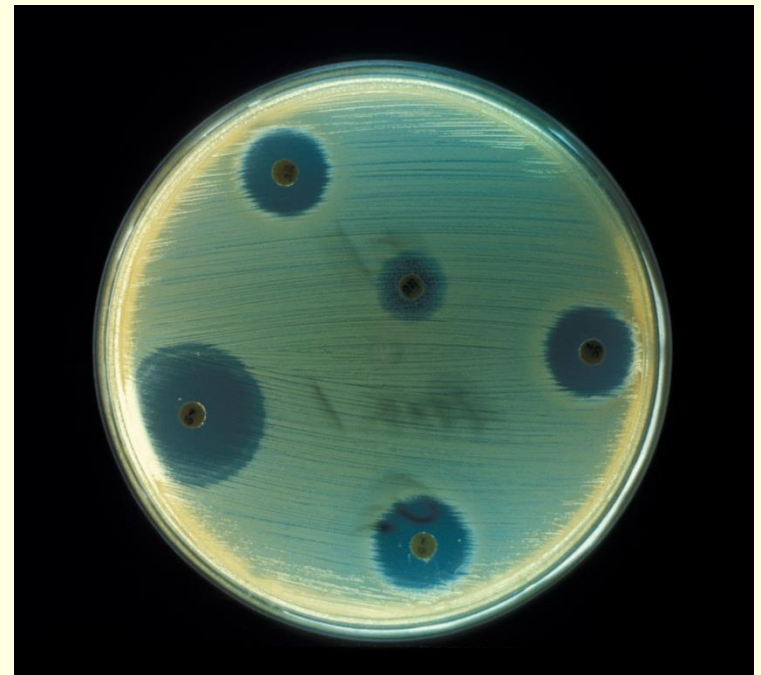
Antibiotics

- Antibiotics can be used to control bacterial and fungal infections but do not effect viruses



Antibiotics

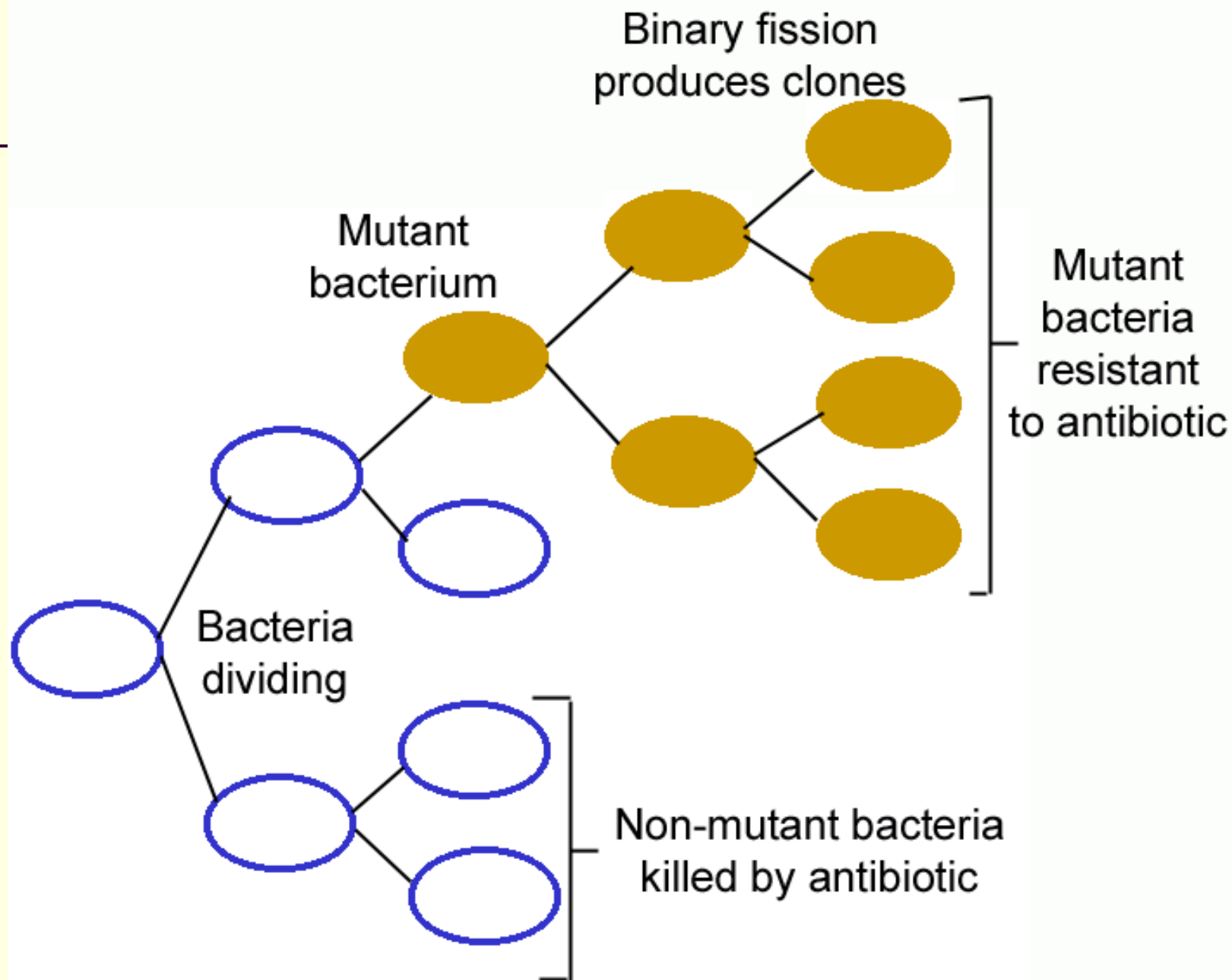
- The first antibiotic **Penicillin** isolated from a fungus by Sir Alexander Fleming
- Now antibiotics are mostly produced by genetically engineered bacteria



Antibiotics

- When an antibiotic is used to treat an infection most of the bacteria are killed
- **Mutations** in bacterial genes can allow bacteria to develop **antibiotic resistance**.
- Antibiotics will then kill 'sensitive' bacteria and favour resistant bacteria.
- Bacterial strains have emerged which are resistant to almost all known antibiotics (**multi-resistant**). As a result present day antibiotics become ineffective. **MRSA** is one example.

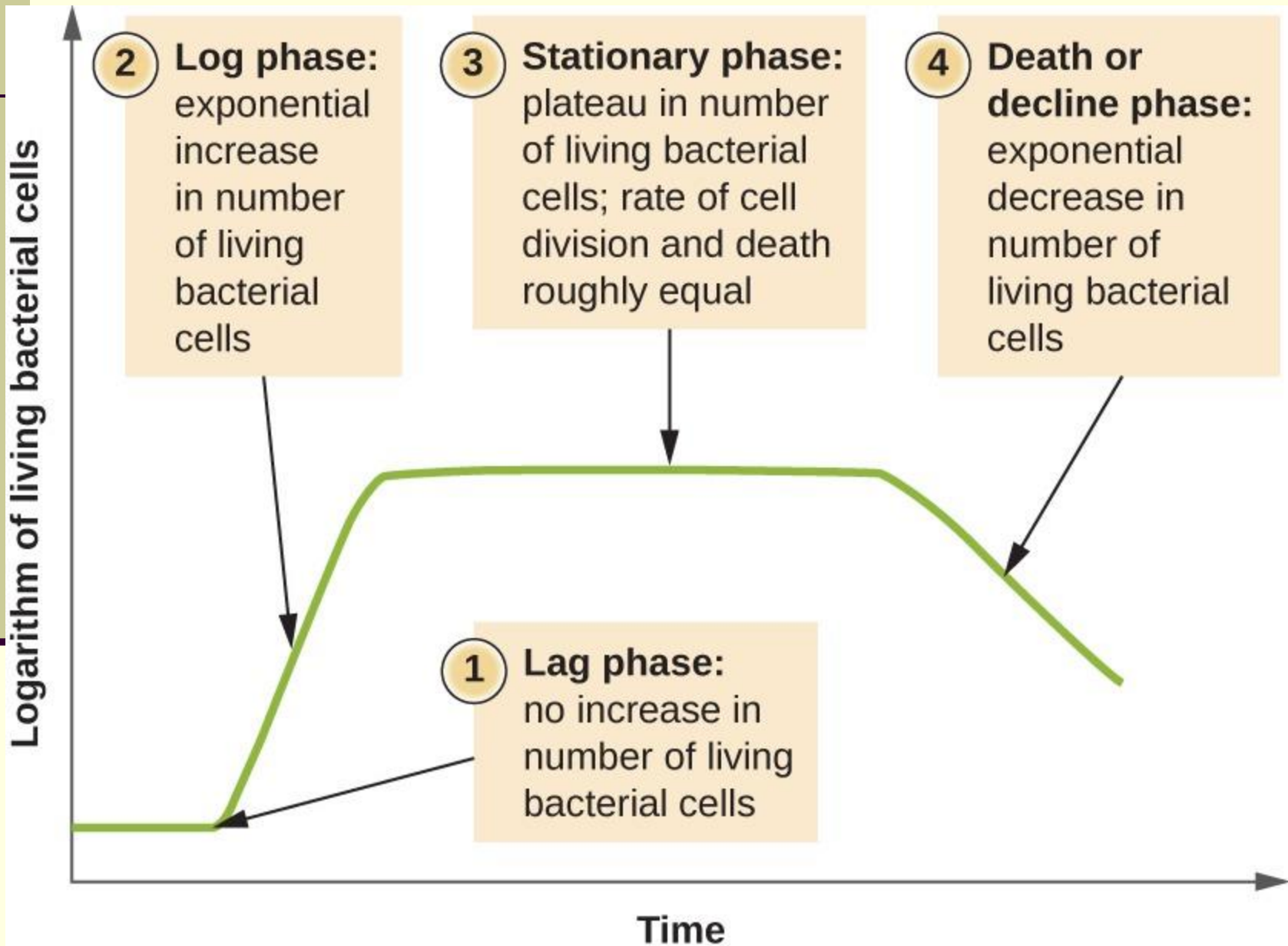
EVOLUTION OF ANTI-BIOTIC RESISTANCE

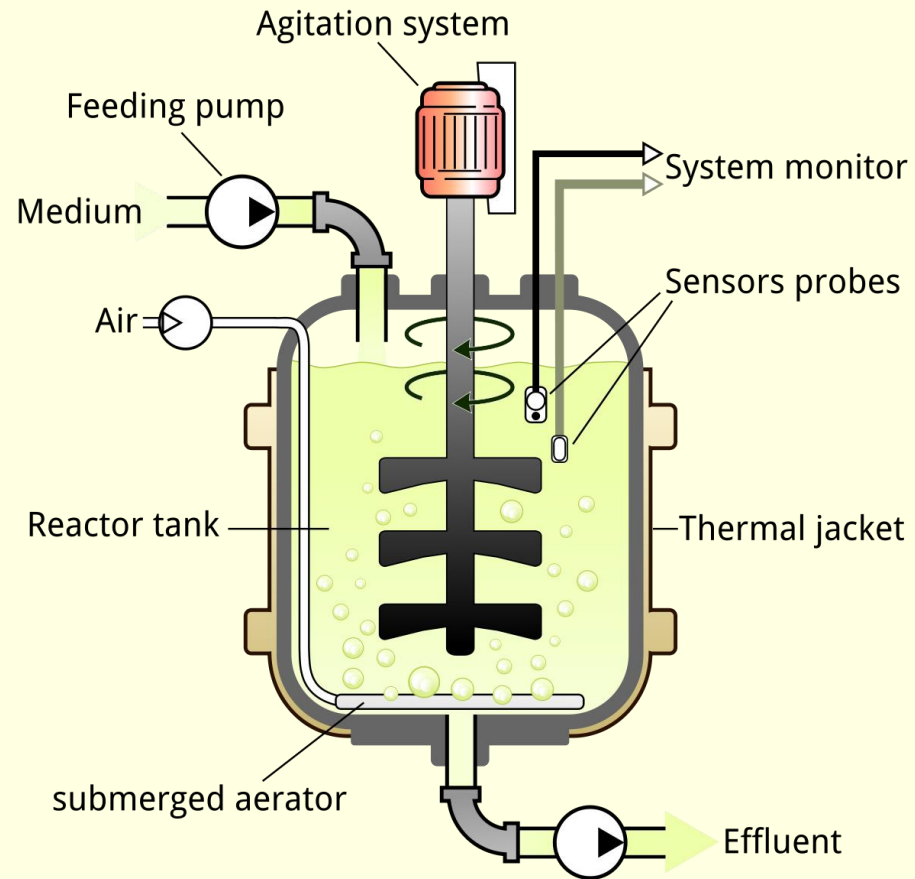


Misuse

Overuse of antibiotics

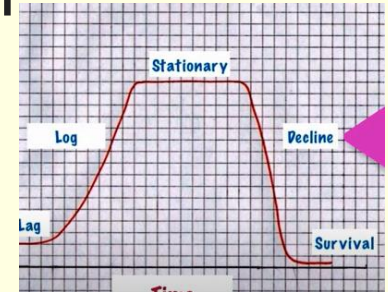
- This results in the increased growth of antibiotic resistant bacteria
- Failure of some patients to complete a course of antibiotics prescribed to them by a doctor allows the bacteria to survive and re-grow





- Batch processing is when a fixed amount of nutrient medium is added to the bioreactor and all the stages of the bacteria growth curve happen

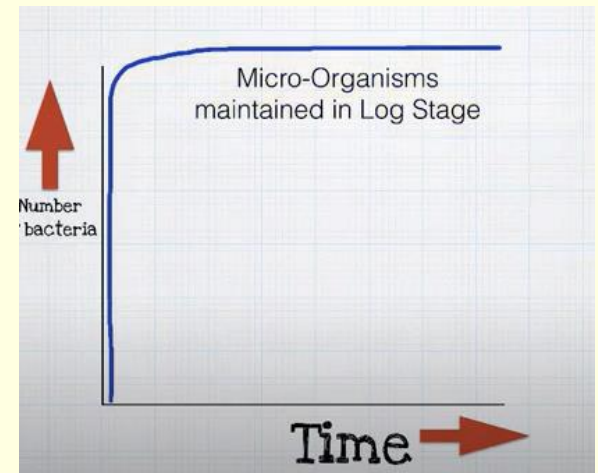
Process starts again.....



- Example of a batch process- Making antibiotics

Continuous Process

- In Continuous Flow nutrients are continuously being added and wastes removed to ensure that it is always in the log phase.
- Example:



Learning Check

- What is meant by the term pathogenic?
- List two beneficial uses of micro-organisms
- What are antibiotics used for?
- What happens if antibiotics are misused?



Syllabus



Can you describe.....

Depth of treatment

- Bacterial cells: basic structure (including plasmid DNA), three main types. Reproduction. Nutrition.
- Factors affecting growth
- Understanding of the term “pathogenic”
- Definition and role of “antibiotics”
- Economic importance of bacteria: examples of any two beneficial and any two harmful bacteria.
- Potential abuse of antibiotics in medicine