Unit 2 Metabolism & Survival

Key Area 6 : Environmental Control of Metabolism

Micro-organisms include :

- **Archaea**
- **Bacteria**
- **Some species of Eukaryotes (e.g. yeast & protozoans)**

Micro-organisms use a **wide-variety of substrates** for metabolism and **produce a range of products** from their metabolic pathways.

Micro-organisms are used because of their **adaptability**, **ease of cultivation (growing)** and **speed of growth**.

<u>Variations in Growth media and control of Environmental factors</u>

When culturing micro-organisms, their **growth media requires raw materials for biosynthesis** as well as an **energy source**.

Many micro-organisms produce all the complex molecules required for biosynthesis

e.g. **Amino acids**

Vitamins

Fatty acids

Other micro-organisms require these to be supplied in the growth media.

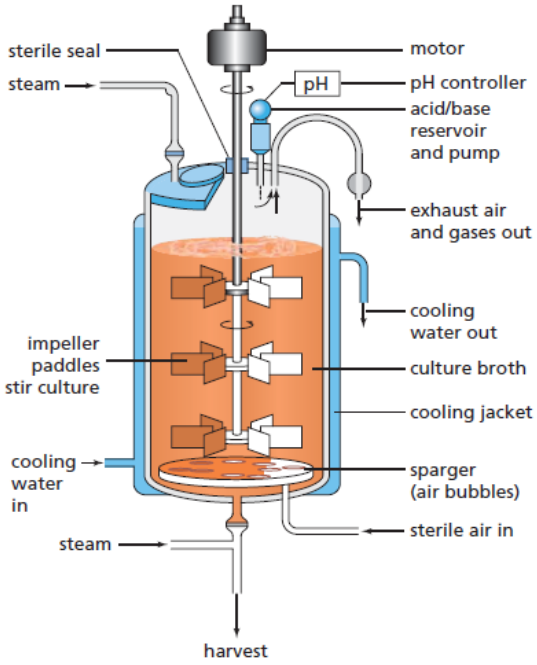
Growth media may contain simple substances suitable for specific micro-organisms or complex ingredients such as **beef extract**.

An **energy source** is derived either from **chemical substrates such as carbohydrates** or from **light in the case of photosynthetic micro-organisms**.

Culture Conditions

Culture conditions include: (Clue : STOP)

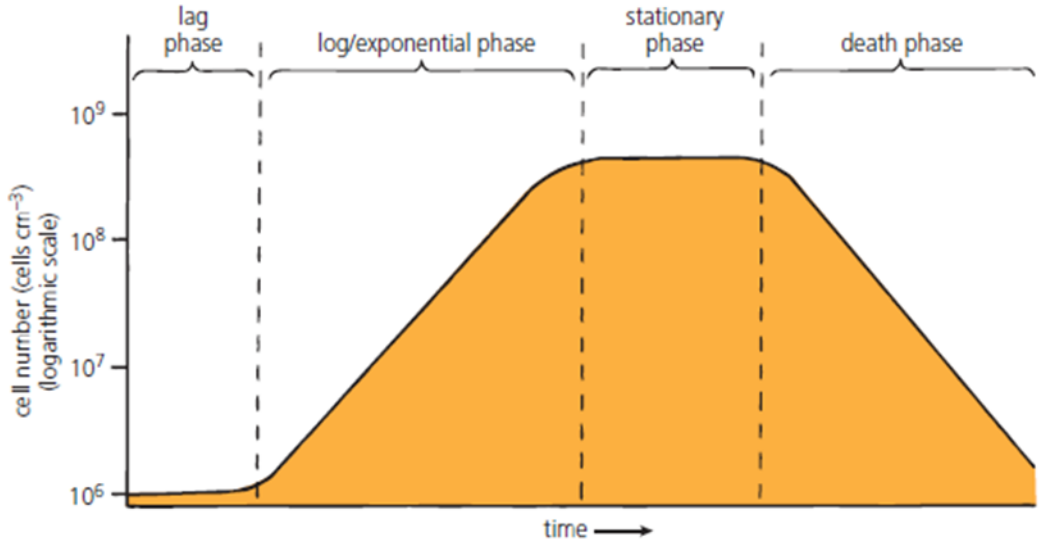
- **Sterility** - sterile conditions in fermenters reduce competition with desired micro-organisms for nutrients and reduce the risk of spoilage of the product.
- **Temperature** must be controlled
- **Oxygen** - Oxygen levels may be controlled by aeration (air pump).
- **pH** - pH can be regulated by adding pH Buffers or the addition of acid or alkali.



An industrial fermenter can be used to culture micro-organisms on a large scale. Sensors are used to monitor temperature, pH and oxygen levels.

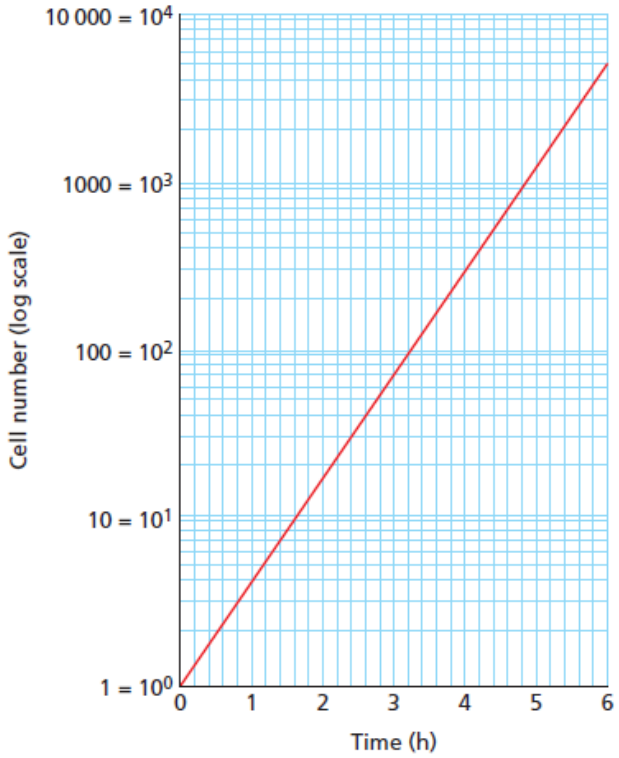
Phases of Growth and changes in culture conditions

Micro-organisms have 4 phases of Growth:



- **Lag** - During the Lag phases **ENZYMES ARE INDUCED** to metabolise substrates.
- **Log/Exponential** - This phase contains the **most rapid growth** of micro-organisms due to **plentiful supply of nutrients**.
- **Stationary** - This phase occurs due to the **nutrients in the culture media becoming depleted** and the **production of toxic metabolites**. **Secondary metabolites**, such as antibiotics, are **also produced**. In the wild these metabolites confer an ecological advantage by allowing the micro-organisms which produce them to outcompete other micro-organisms.
- **Death** - This phase occurs due to the **toxic accumulation of metabolites** or the **lack of nutrients** in the culture.

Semi-logarithmic scales can be used to show the exponential growth phase of micro-organisms. Use of semi-logarithmic graphs to plot the exponential growth phase, produces a straight line. On the cell number scale, the division between 1 and 10 is the same size as that between 10 and 100.



Viable and Total Cell Count

VIABLE cell counts involve counting **only the LIVING micro-organisms**.

TOTAL cell counts involve counting **viable and dead cells**.

Only viable cell counts show a death phase where cell numbers are decreasing.