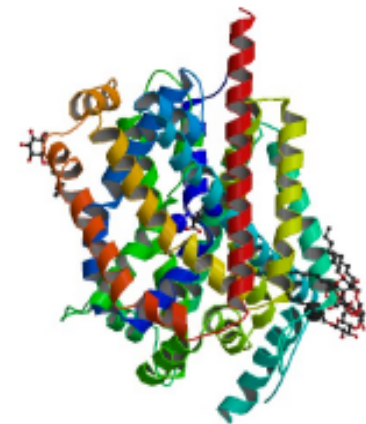


Lectures 5 and 6: Microbial Nutrition and Growth

* A large amount of the material related to Microbial Nutrition and Growth is application-based and will be covered in detail in lab 5 and 6. Please use the crossword puzzle at the end of these lectures as a review of this material.

Why is it important for microorganisms to be able to transport molecules into and out of the cell?



LeuTAa is a bacterial Na⁺/Cl⁻ transporter that is a homologue of human transporters that uptake biogenic amines such as dopamine. Protein Databank 2A65.

I. Uptake of nutrients by the cell

A.

1. Small molecules such as _____ move across the membrane (without a transporter) from a region of higher concentration to one of lower concentration.

_____ is necessary.

2. _____ depends _____ on the size of the concentration gradient ((Fig 6.3 (8th ed.) or 3.10 (9th ed.)).

B.

1. Mediated by either _____ proteins that allow a molecule to cross from a region of _____

_____. This can eliminate a difference in concentration but cannot create one. _____ output.

2. Carriers

a. Show _____ and accommodate one solute at a time.

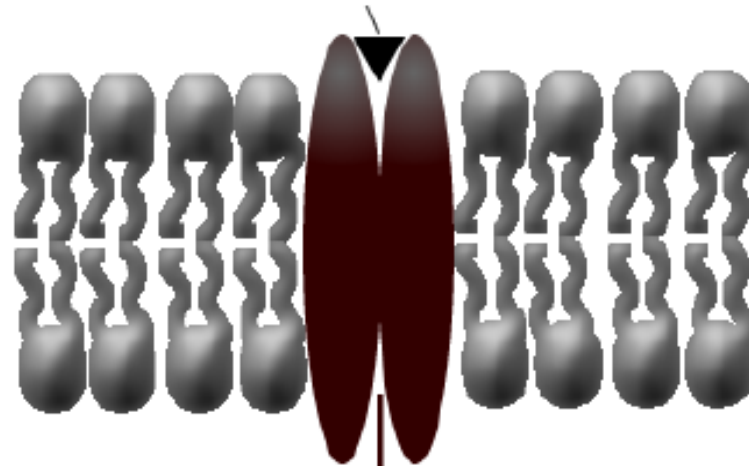
b. The rate of transport increases more rapidly and sooner with a carrier, but the carrier can become _____ (Fig 6.3 (8th ed.) or 3.10 (9th ed.)).

*Simple, passive diffusion
and channels vs. carriers*
AN ANALOGY

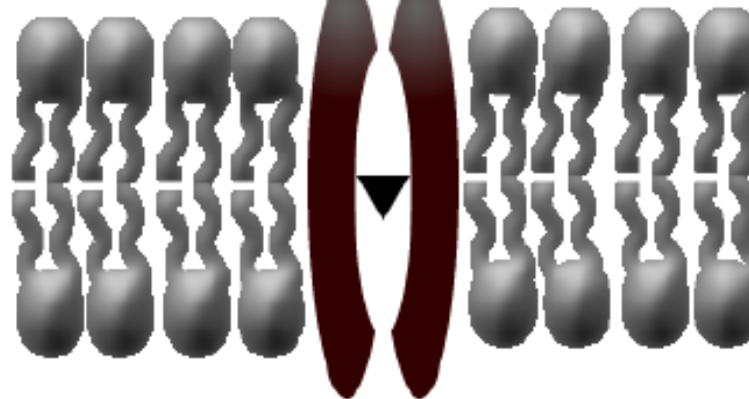


3. Carrier mechanism:

The solute molecule binds to the outside of the carrier causing a



The molecule is transferred to the interior of the cell.



*Since this process is concentration dependent, it is

4. In order to maintain a concentration gradient that is amenable to transport, many cells immediately _____ the transported molecule into something else or eukaryotic cells may _____ it to another compartment.

5. Examples:

a. Carriers: Certain K^+ uptake systems

b. Channels:

_____ and _____ in many bacteria.

*Facilitated diffusion is observed much more often in _____ than in prokaryotic svstems. Why?



Aquaglyceroporin -a facilitator found across the inner membrane of *Escherichia coli*

Biophys.J. **2008**, 94, 832-839

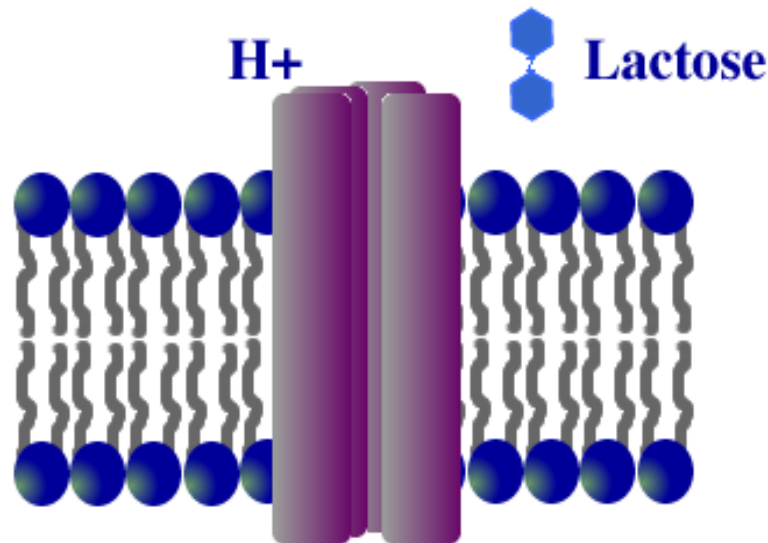
image available at <http://www.edam.uhp-nancy.fr/ABF/applications.html>

C. - can accumulate molecules against a concentration gradient ().

1. Transport systems that use the proton motive force (called the); Microbiol Mol Biol Rev. 1998 March; 62(1): 1-34.

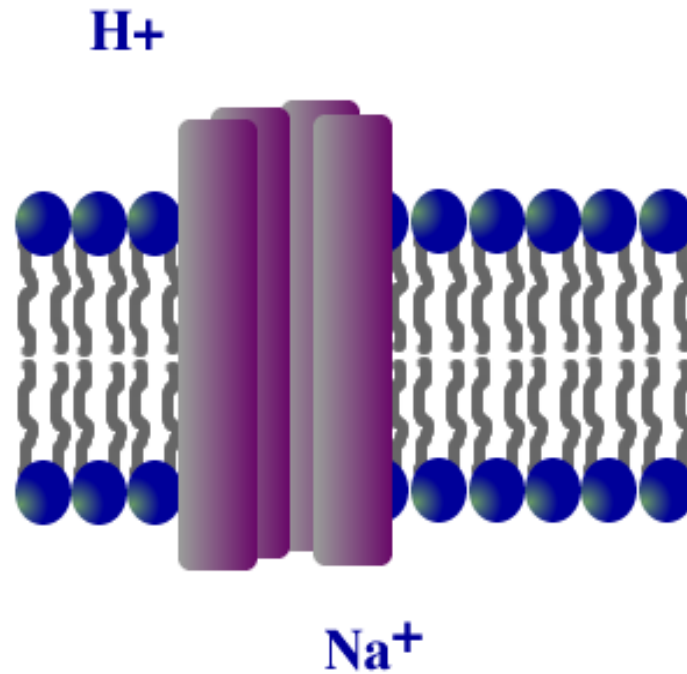
a. -The linked transport of two substances in the

The of *E. coli* is a symport.



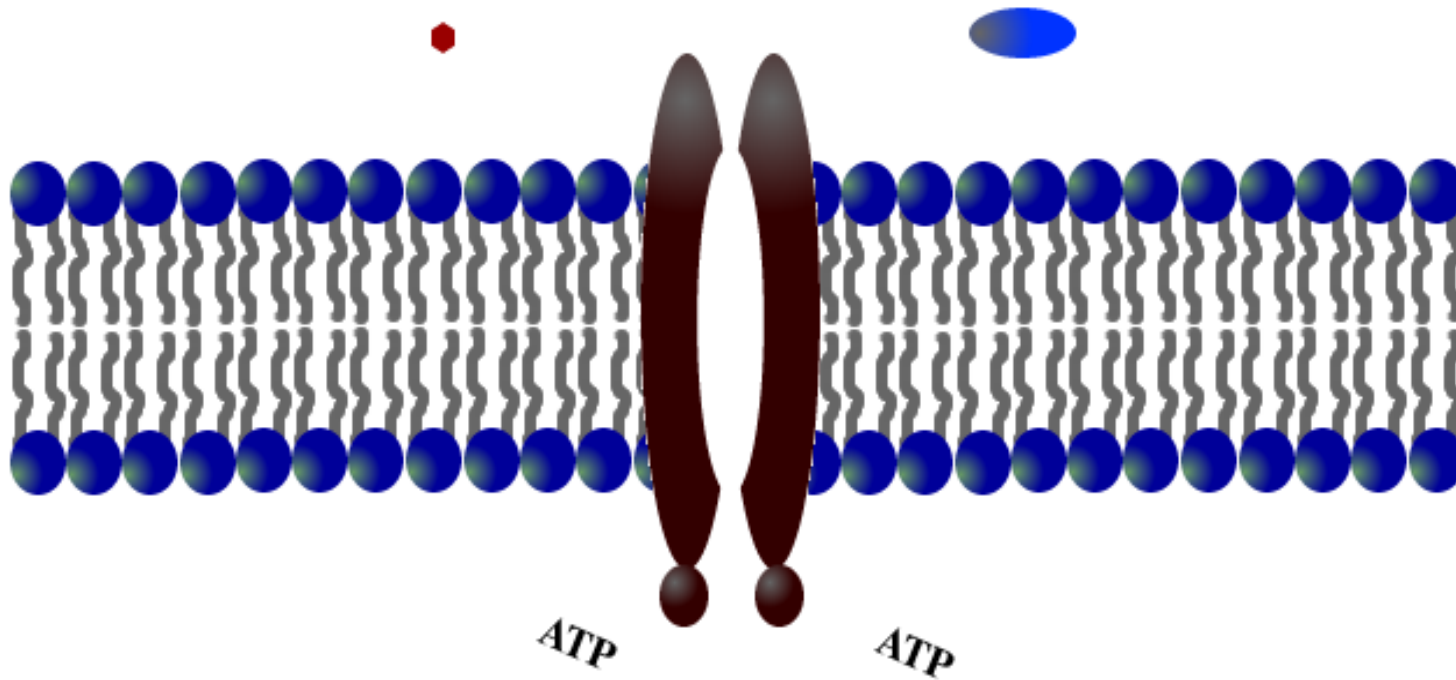
- b.
- The linked transport of two substances in opposite directions.

The Na⁺ symporter of *E. coli* is an antiport.

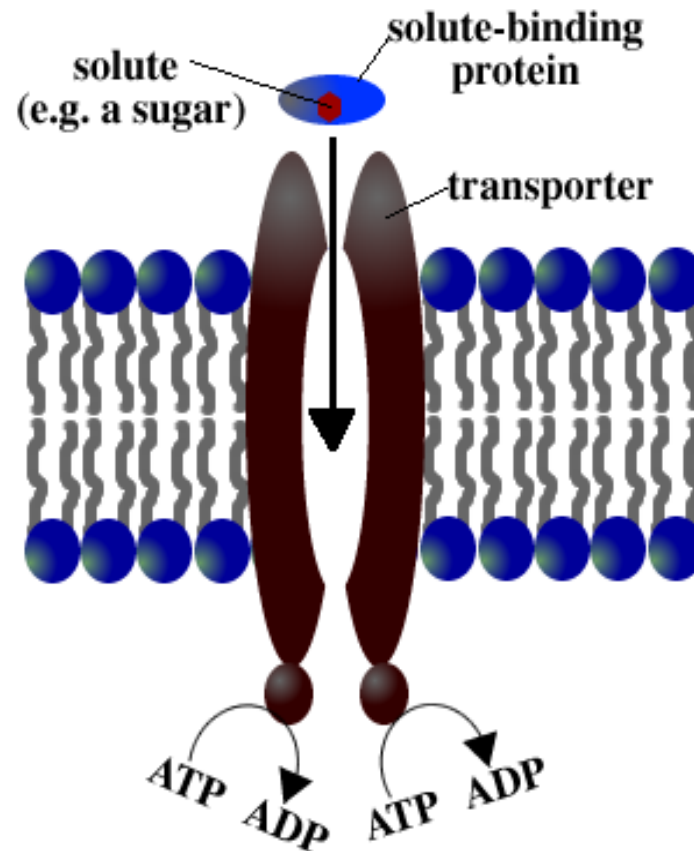


2. Transport systems that use ATP = TP binding asette
() transport systems.
- Utilizes a binding protein that is located outside
the membrane to deliver the molecule to the transporter.

***E. coli* uses ABC transporters to bring in a
variety of .**



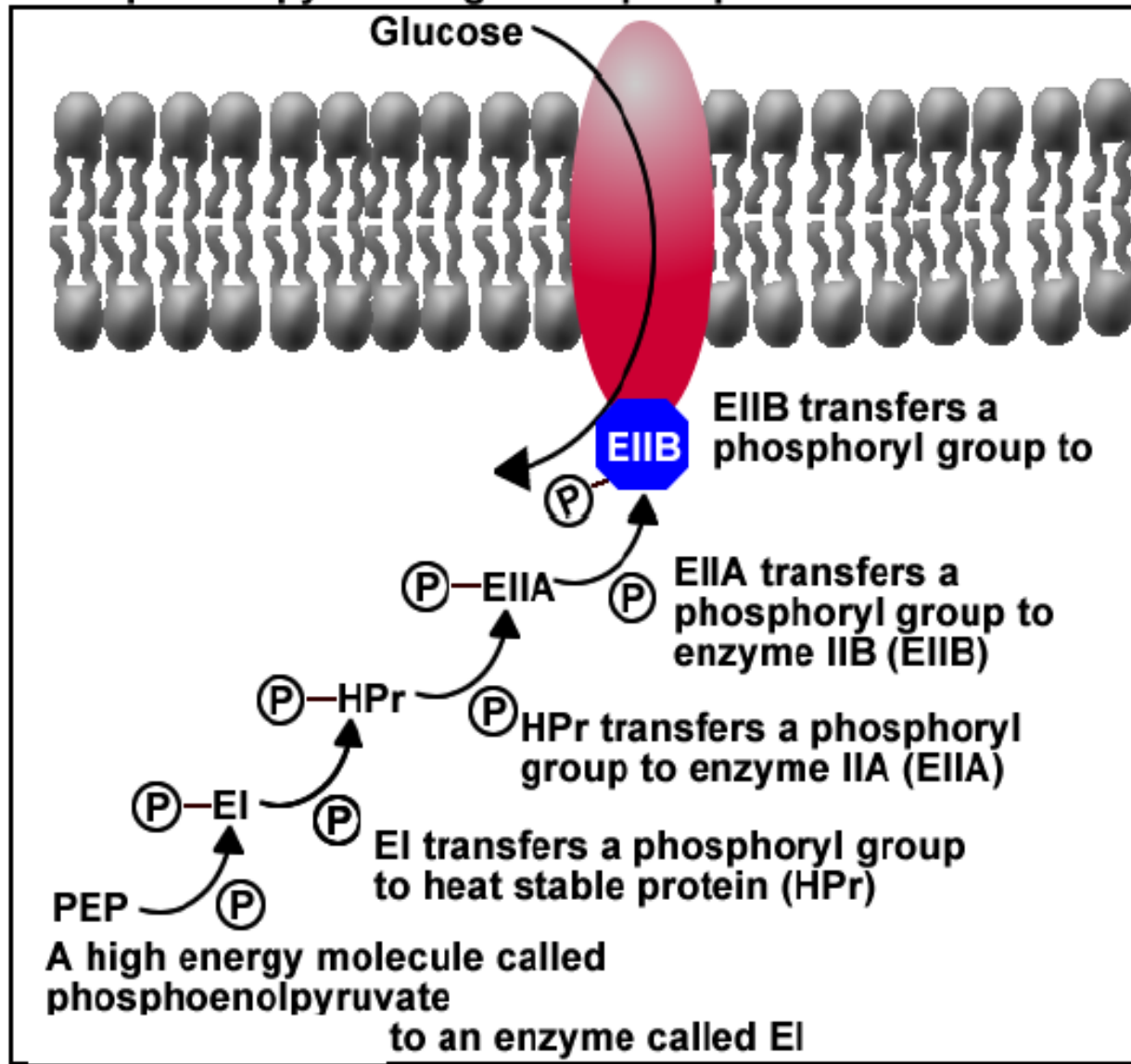
E. coli uses ABC transporters to bring in a variety of sugars and amino acids.



D.

-A molecule is chemically altered during its passage through the transporter (e.g. in the phosphotransferase system, sugars are phosphorylated as they enter the cell).

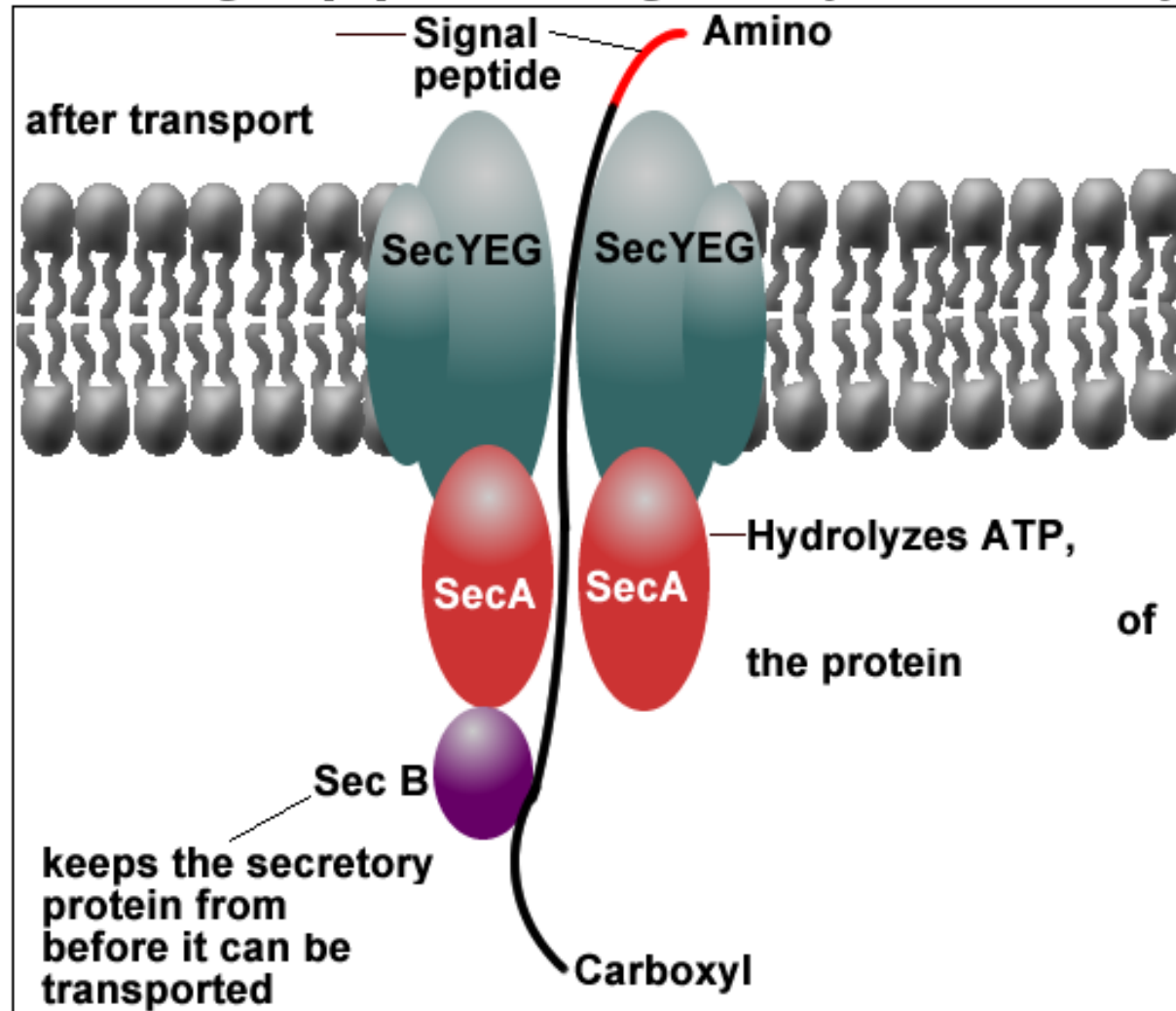
Phosphoenolpyruvate: glucose phosphotransferase



II. Protein Secretion (prokaryotes)

The Sec-Dependent Pathway (General Secretion Pathway)

1. Proteins to be secreted this way are synthesized with a signal peptide at their amino terminus.
2. The signal peptide is recognized by Sec machinery.



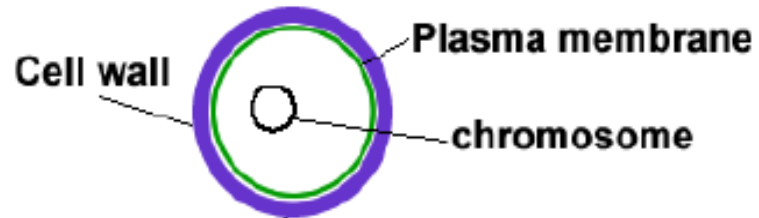
III. Principles of Bacterial Growth

A.

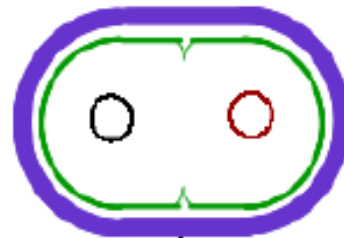
An increase in the number of cells in a population.

B. Cells often reproduce by _____ :

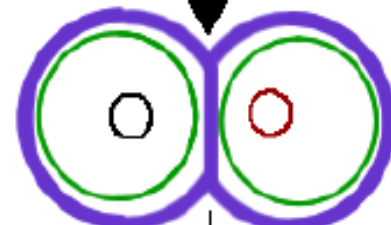
BACTERIAL CYTOKINESIS



As a bacterial cell readies for division, it becomes larger (and increases in volume). The chromosome and plasmids

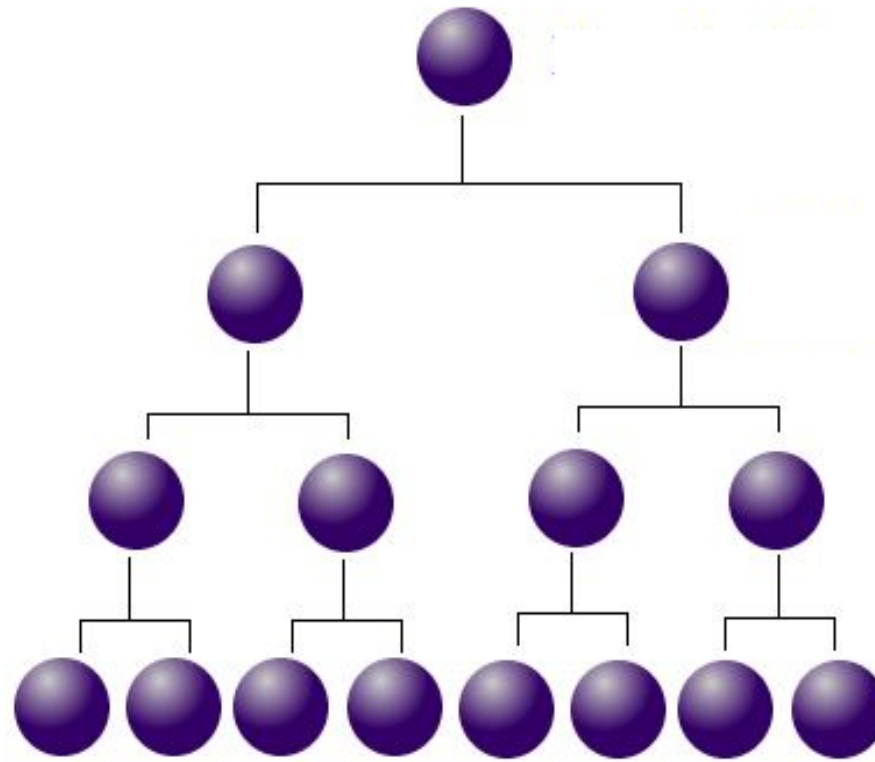


A _____ begins to form and expands through the entire cell, creating two separate compartments



Two separate daughter cells are formed. Depending on the species the cells may stay associated (diplo arrangement)



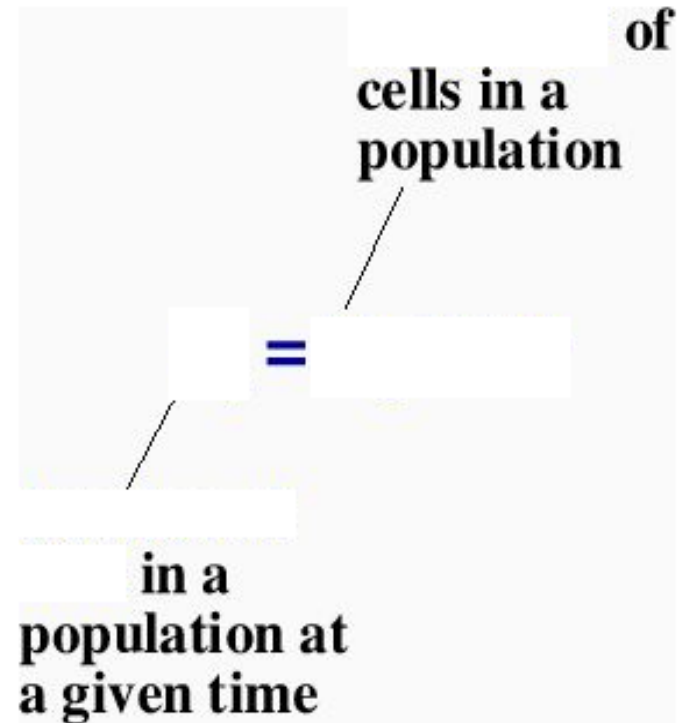


The increase in the cell #s is

The number of cells after n divisions =

-For example after the third cycle of divisions and the number of cells =

It is often desirable to calculate the number of cells in a population that originated from more than a single cell:



C. = the time it takes for a population to double
in number.

Many bacteria -

Escherichia coli - (under certain environmental conditions)

Mycobacterium leprae -10 to 30 days

(See also table 7.3 (8th) or 7.29 (9th))

Sample situation:

10 cells of a microorganism land on your ham sandwich. It sits in a warm room for 4 hours before you eat it for lunch. If this microorganism has a doubling time of 20 min., how many microorganisms do you eat?

of divisions =

$$N_t = N_0 \times 2^n$$

$$N_t =$$

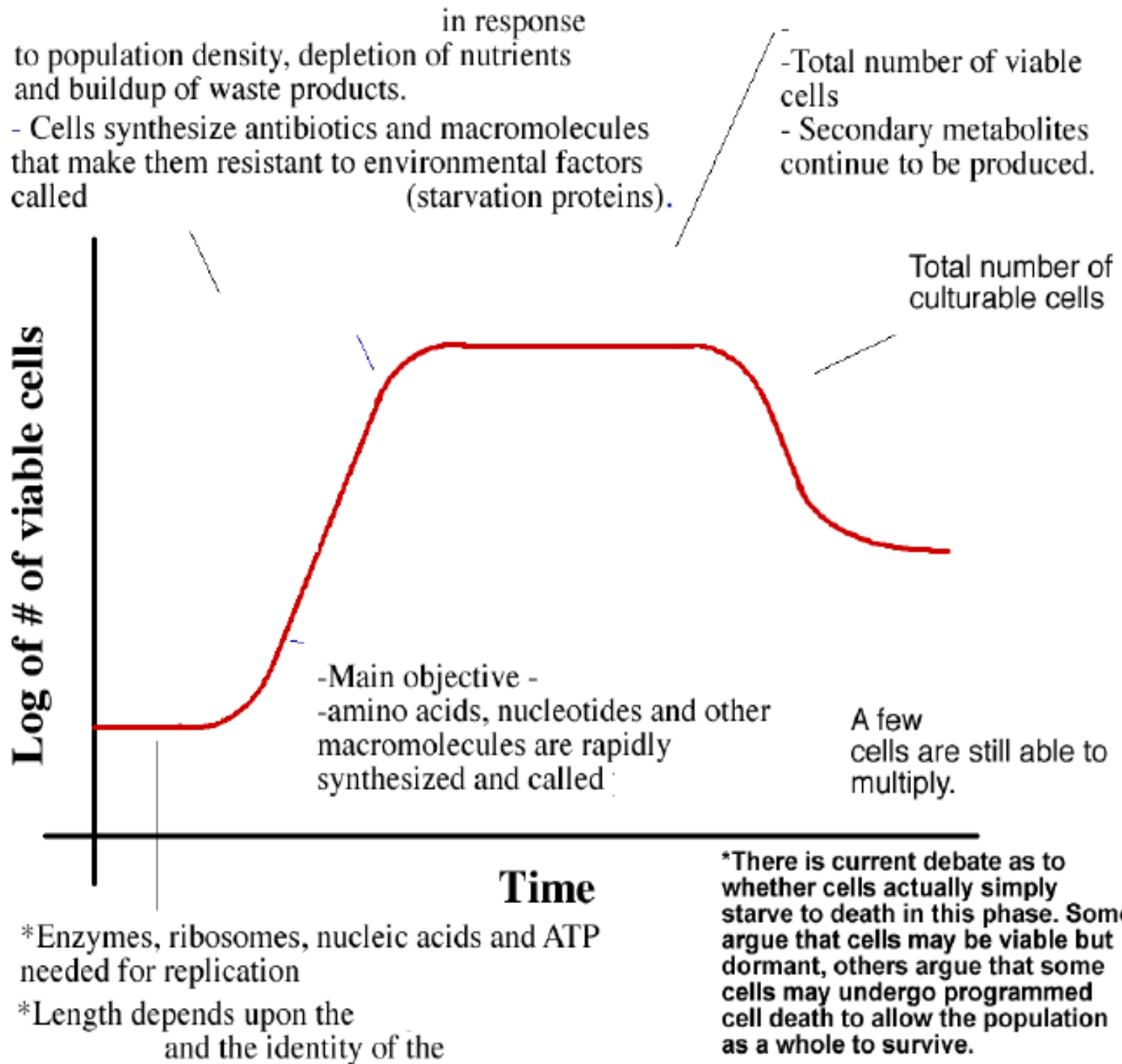
IV. Bacterial Growth in Laboratory conditions

A. In lab, we grow organisms in tubes, flasks or on plates. In these systems nutrients are _____ and waste products are not _____. These are called _____. Growth in these conditions (particularly a shaken culture) is described by a growth curve.

B. The Growth Curve



Check out the YouTube Channel!



During which stage of growth do you think that a bacterium would be most susceptible to antibiotics?

- a. Lag phase
- b. Log phase
- c. Stationary phase
- d. Death phase

How is growth in nature often different than growth in a closed system?

C. Toxic derivatives of oxygen (O₂)

1. Oxygen can be naturally converted into two toxic forms:

- a.
- b.

***Cause damage to cell membranes, DNA and proteins.**

2. Some organisms are equipped with enzymes that can superoxide and hydrogen peroxide.



**Most strict anaerobes lack these enzymes*