

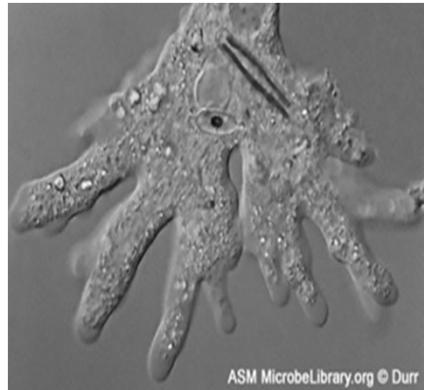
Microbial Biotechnology

The Structure of Microbes

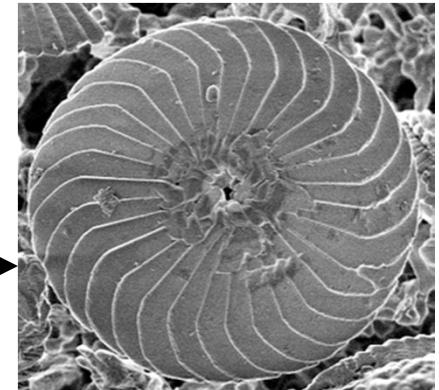
- **Microbes (microorganisms)** are tiny organisms that are too small to be seen individually by the naked eye and must be viewed with the help of a microscope



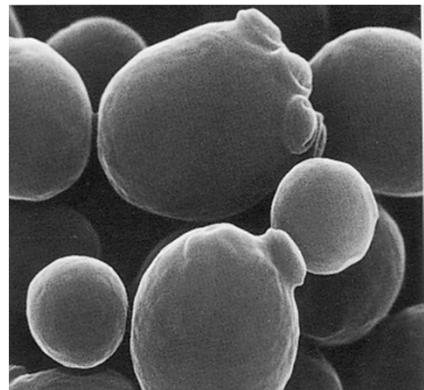
Microorganisms



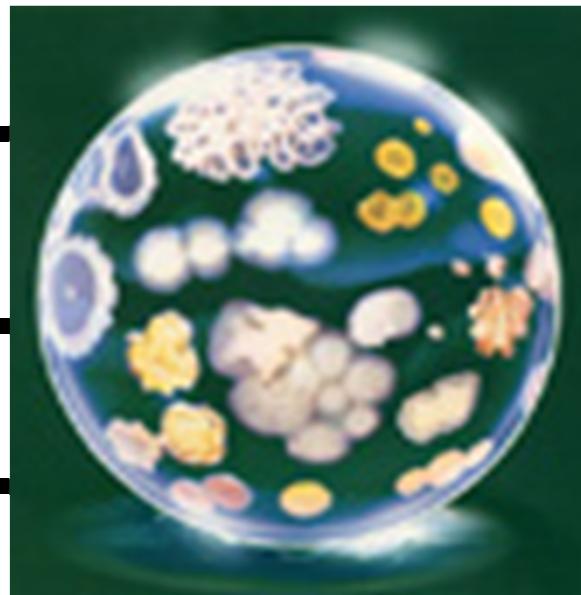
Protozoan



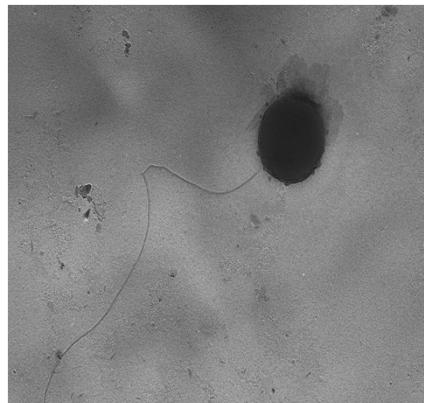
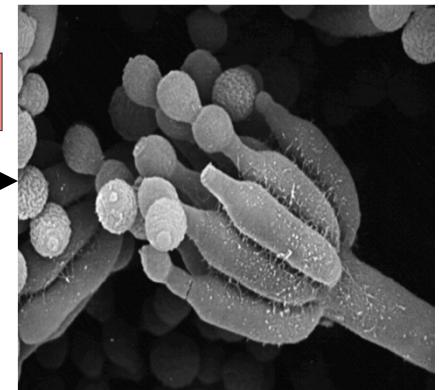
Algae



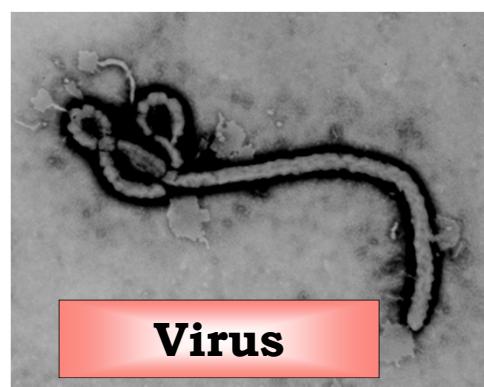
Yeast



Mold

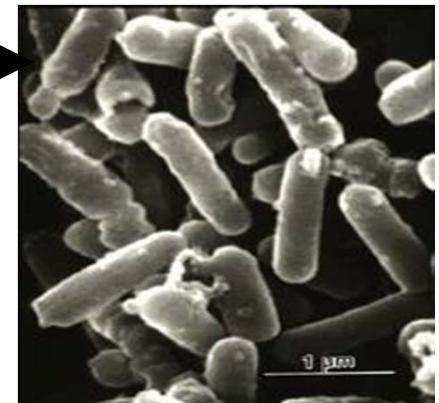


Archaeon



Virus

Bacterium



1 μm

Interesting Facts



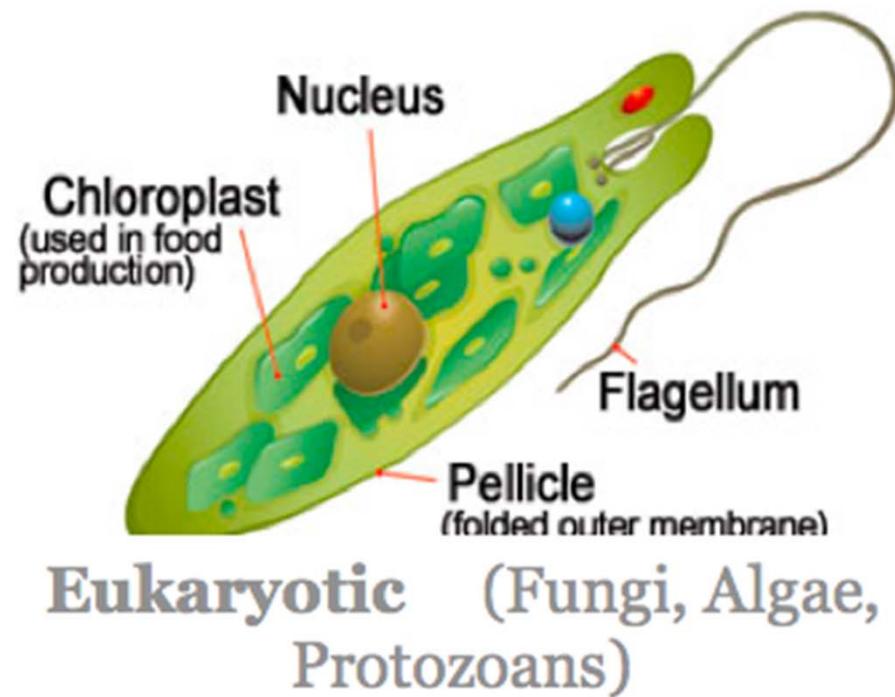
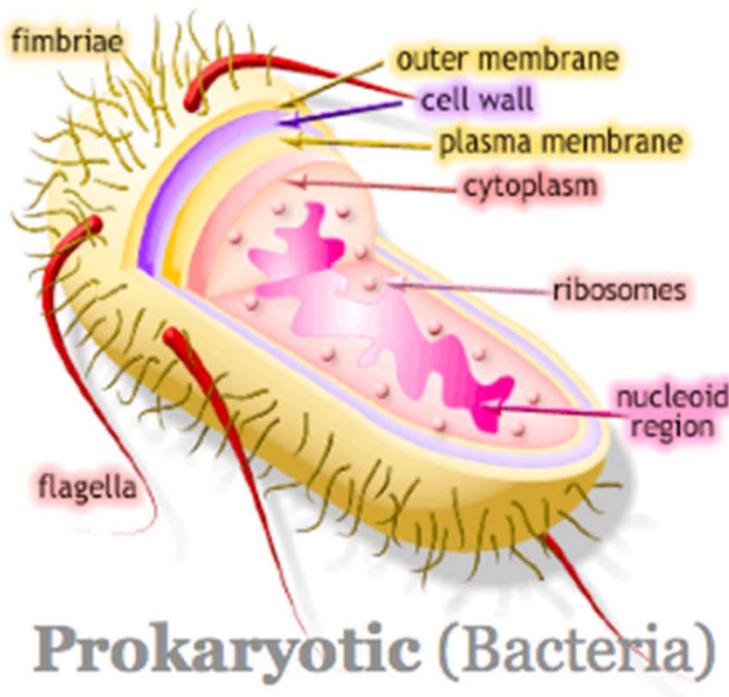
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- Microbes have existed on the earth for over 3.5 billion years
- 50% of the living matter is comprised of microorganisms
- Less than 1% of all bacteria have been identified, cultivated and studied in the laboratory
- Yet we are literally surrounded by microbes all the time

Germs, Germs, Everywhere

Microbial Structure

Often the use of microorganisms as biotech tools depends on their cell structure.



Structural Features of Bacteria

- Small (1–5 μm)
- Usually single (circular) chromosome that *lacks* histone proteins
- **No nucleus**; DNA is contained in a single, circular chromosome
- May contain **plasmids**
- **Cell wall** that surrounds plasma membrane contains **peptidoglycan**; provides rigidity for protection
- Some bacteria contain an outer layer of carbohydrates in a structure called a **capsule**

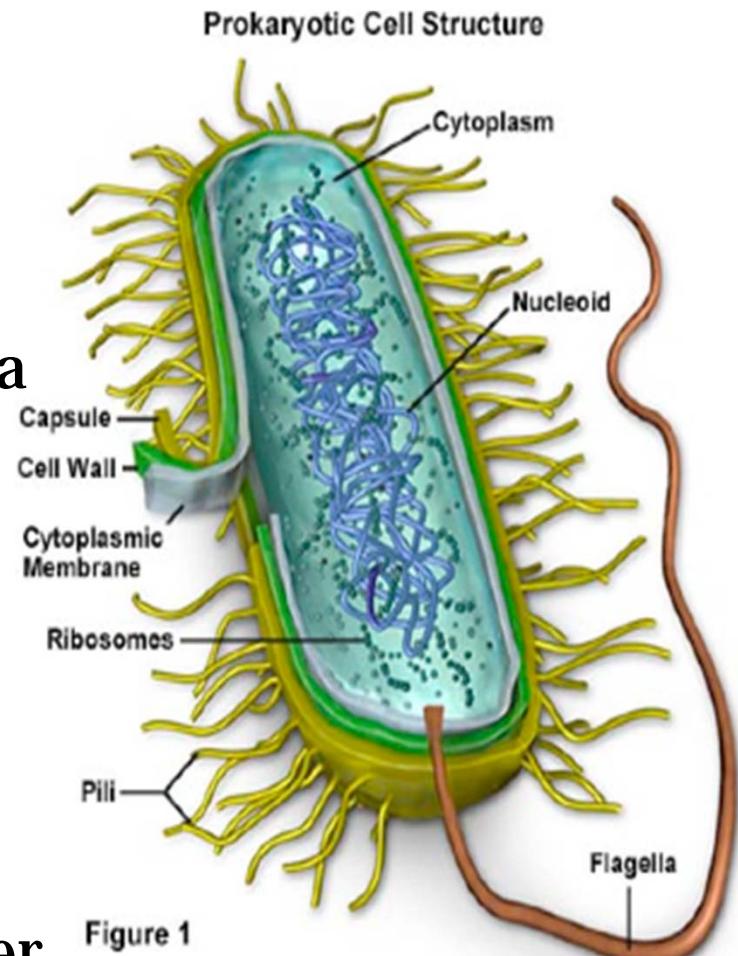
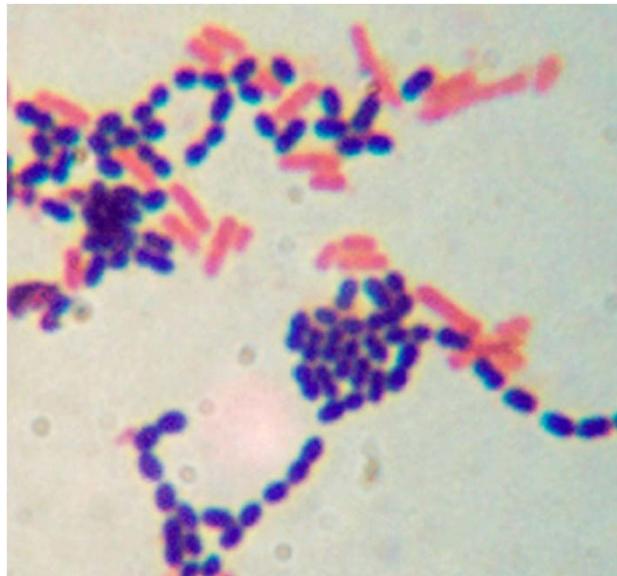


Figure 1

Prokaryotic Classification

Bacteria are classified by the **Gram stain**.

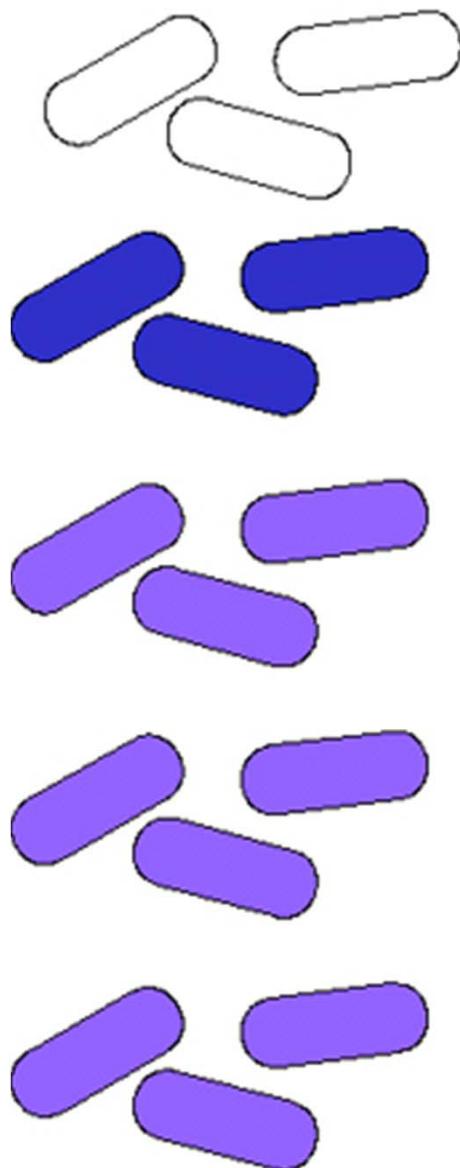


- **Gram positive** bacteria appear **purple** after Gram staining.
- **Gram negative** bacteria appear **pink** after Gram staining.

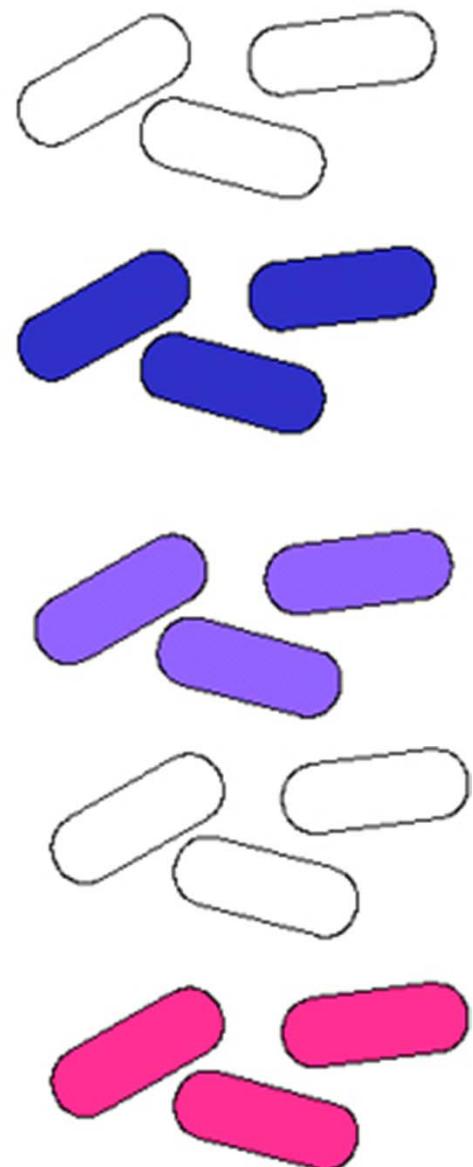
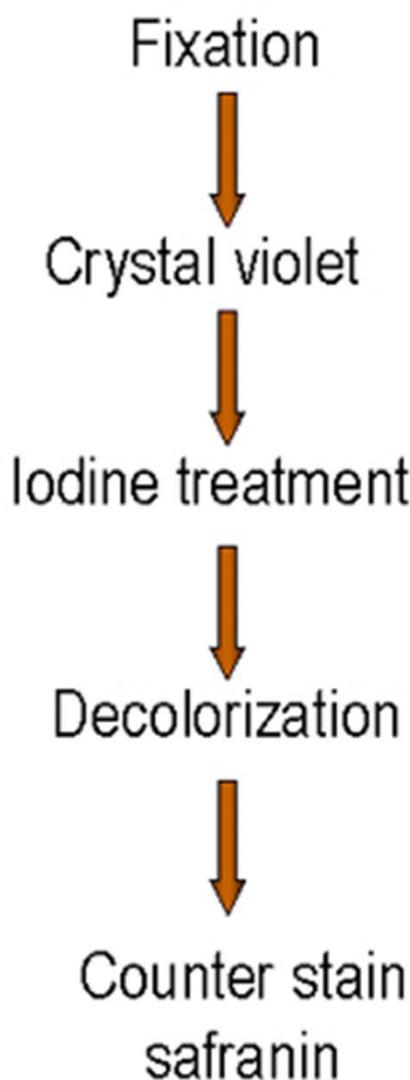
Comparison of gram + and gram - bacteria

Cell wall structure	Gram + bacteria (stain purple)	Gram – bacteria (stain pink)
Complexity	Simple	Complex
Amount of peptidoglycan (protective sugar network)	Large amount	Small amount
Peptidoglycan placement	In outer layer of bacteria	Covered by outer membrane (protects from antibiotics)
Outer membrane	Absent	Present with lipopolysaccharides (toxic to host) attached

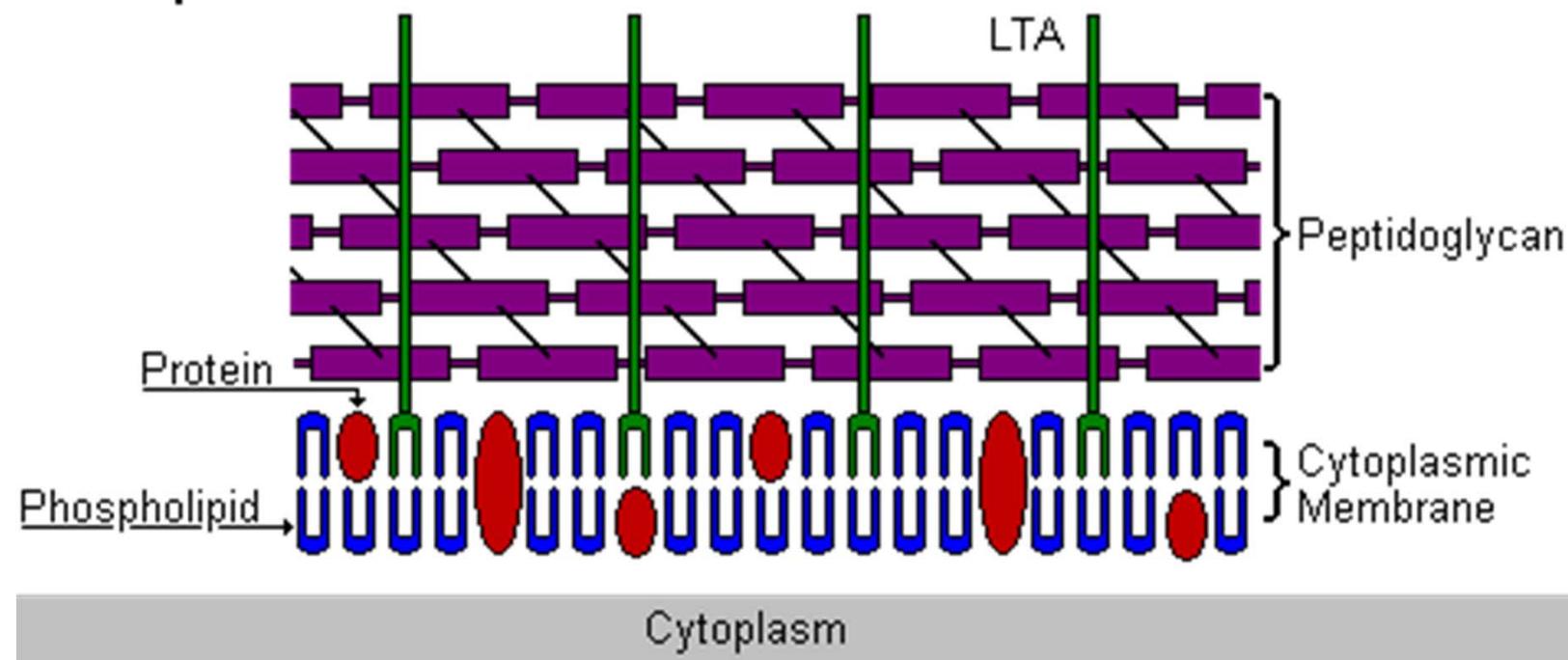
Gram Positive



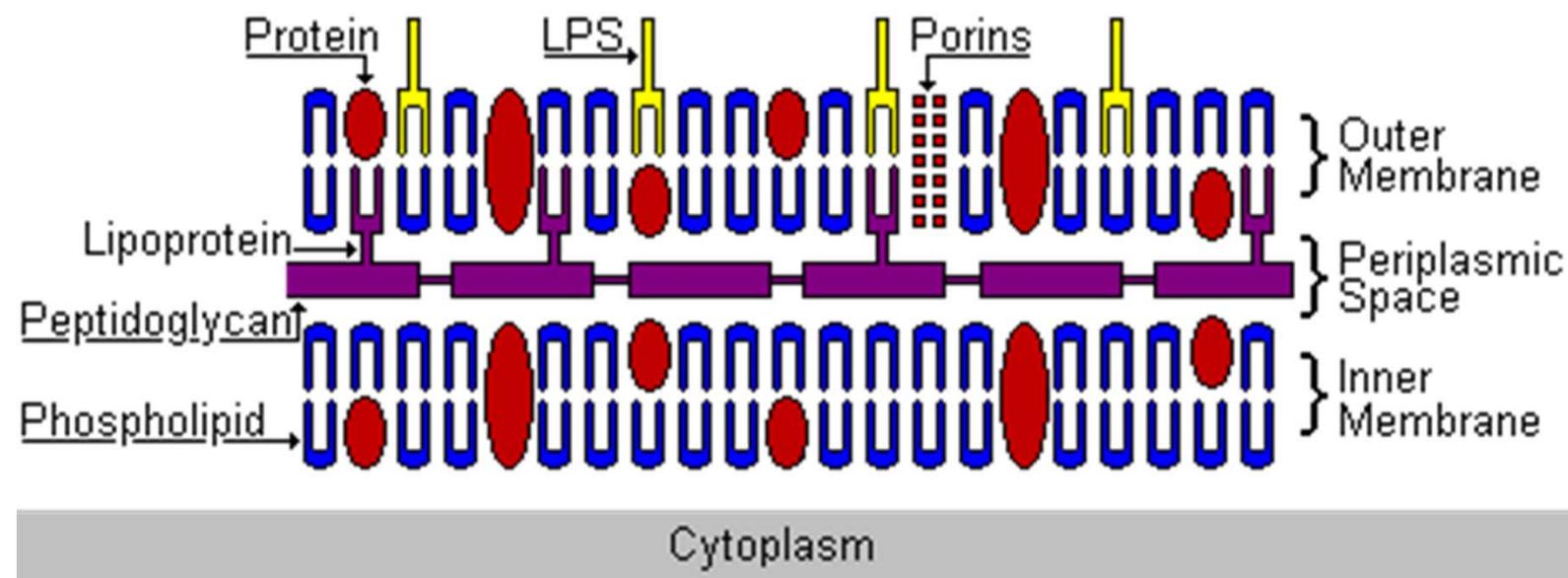
Gram Negative



Gram-positive Cell Wall

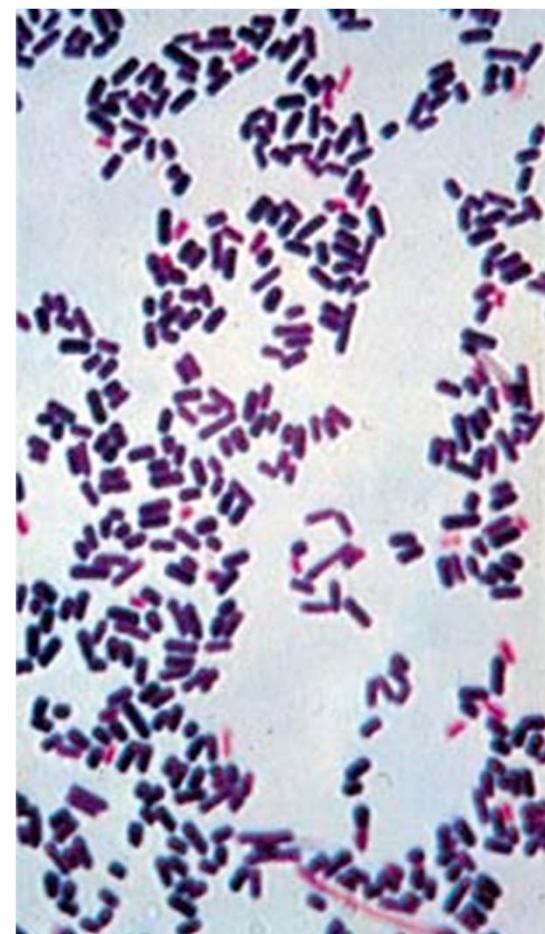


Gram-negative Cell Wall



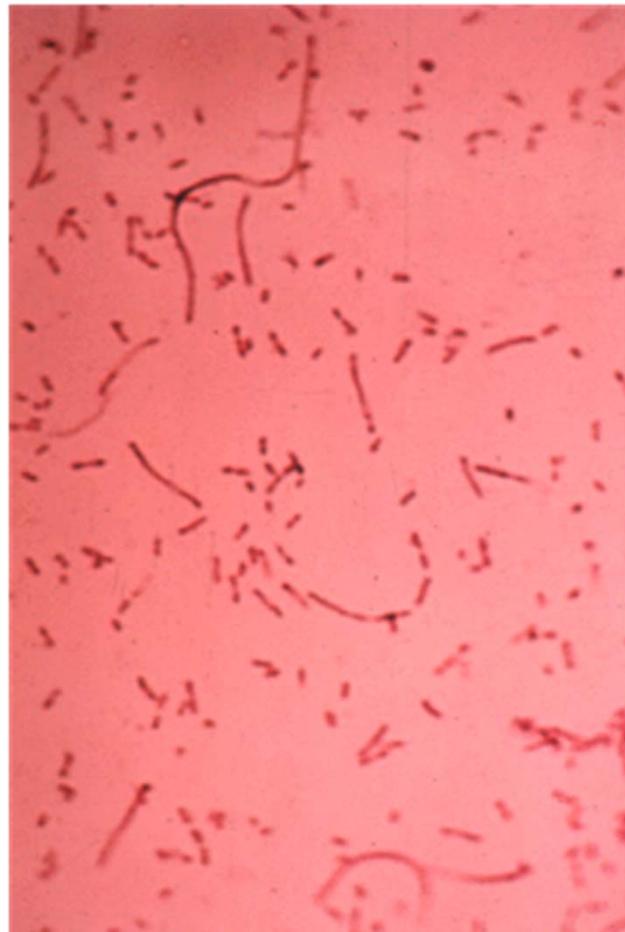
Gram Positive

- **Gram positive** bacteria have a *thick* cell wall rich in peptidoglycan
- Gram-positive bacteria are important in industry and medicine
- Many antibiotics will kill Gram-positive bacteria
- Examples include *Staphylococcus aureus*, *Mycobacterium tuberculosis*, *Bacillus anthracis*, *Bacillus subtilis*



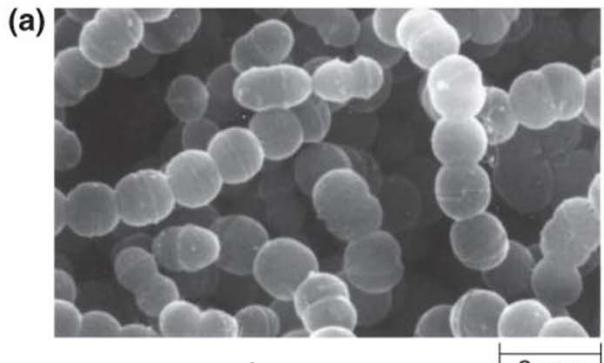
Gram Negative

- **Gram negative** bacteria have complex cell walls with less peptidoglycan
- Many species of Gram negative bacteria are pathogenic (not all)
- Gram-negative bacteria are often tougher to kill, resisting common antibiotics
- Examples include *Escherichia coli*, *Salmonella enteritidis*, *Haemophilus influenzae*

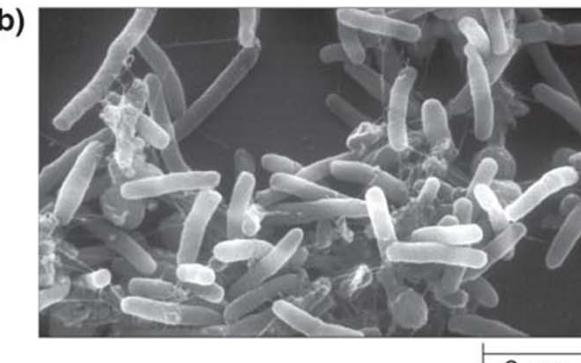


What bacteria look like

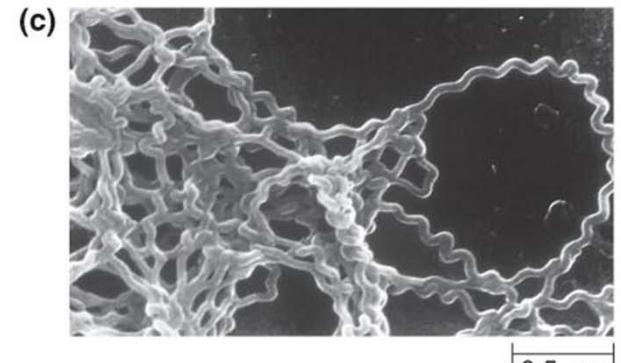
- Bacteria vary in size and shape
 - Most common shapes
 - **Cocci** – spherical cells
 - **Bacilli** – rod-shaped cells
 - **Spiral** – corkscrew-shaped cells



spheres or
cocci growing
in chains



rods



cork-screw

The Structure of Microbes

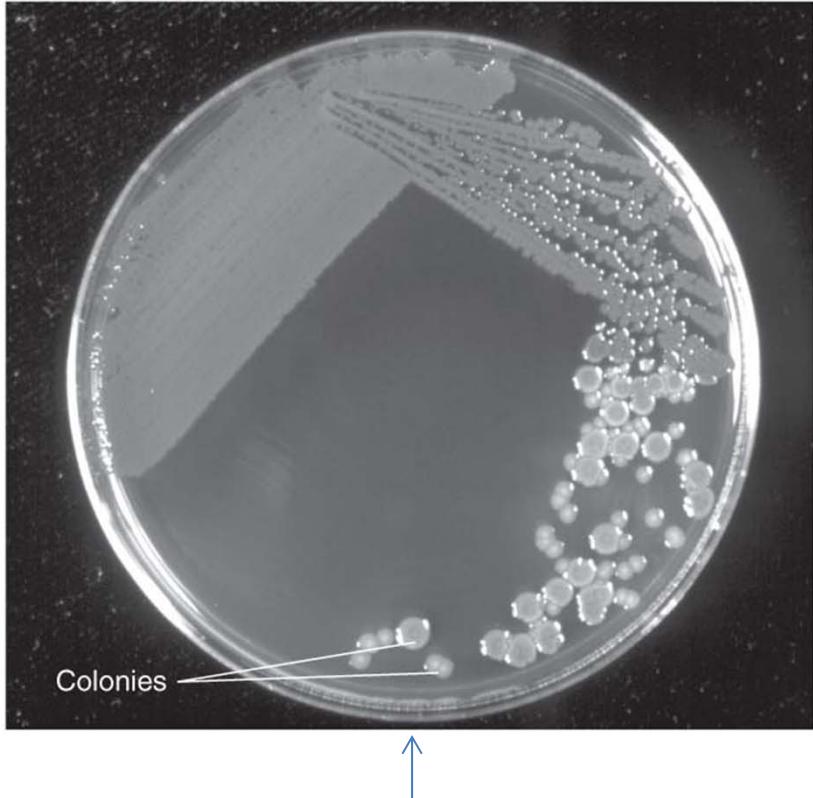
- Single, circular chromosome is relatively small
 - 2–4 million base pairs
- Some bacteria contain **plasmids** as well
 - Plasmids often contain genes for **antibiotic resistance** and genes encoding proteins that form connecting tubes called ***pili***
 - Plasmids are an essential tool for biotechnology

The Structure of Microbes

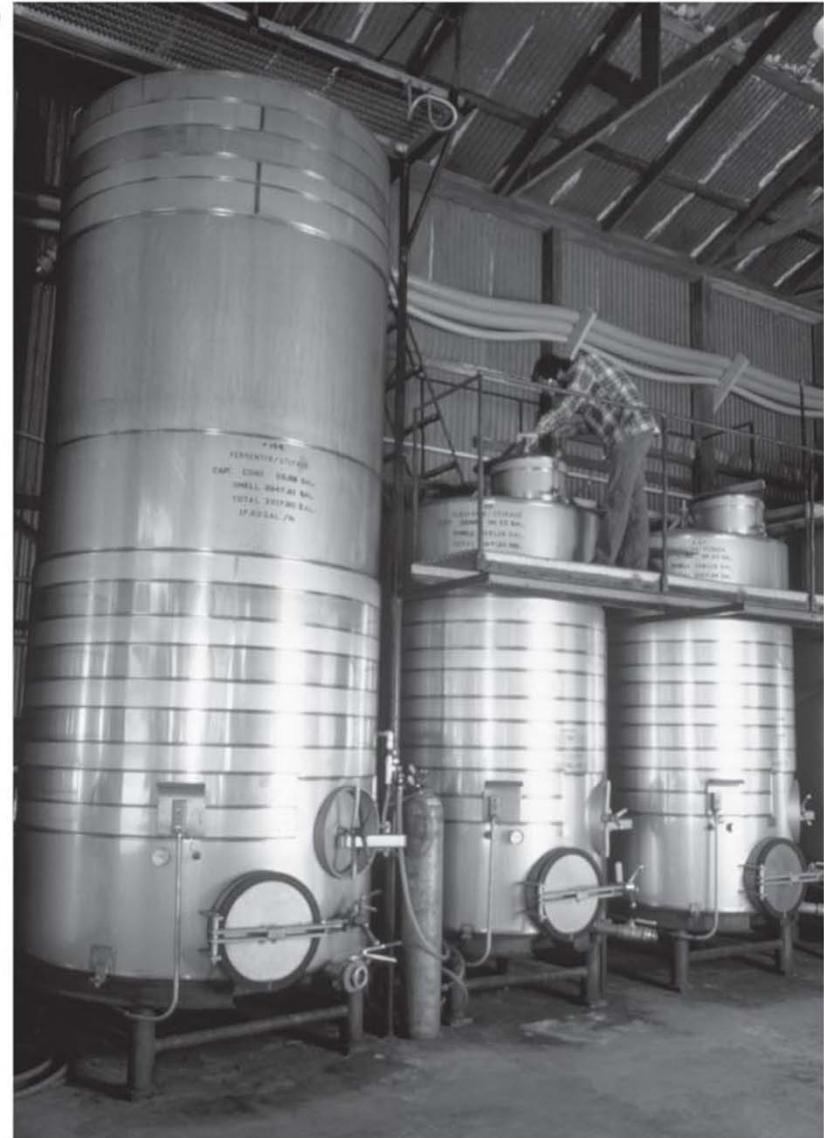
- Bacteria grow and divide rapidly
 - Divide every 20 minutes or so
 - Millions of cells can be grown on small dishes of agar or in liquid culture media
- Easy-to-make mutant strains to be used for molecular and genetic studies

How we cultivate bacteria

(a)



(b)



Cultivated on small scale in petri dishes

Cultivated on large scale in
fermenters

Scientific names

- Are italicized or underlined.
- The genus is capitalized and the specific epithet is lower case.
- Are “Latinized” and used worldwide.
- May be descriptive or honor a scientist.

Staphylococcus aureus.

- Describes the clustered arrangement of the cells (staphylo-) and the golden color of the colonies.
- *Escherichia coli* - Honors the discoverer, Theodor Eshcerich, and describes the bacterium's habitat, the large intestine or colon.
- After the first use, scientific names may be abbreviated with the first letter of the genus and the specific epithet:

Staphylococcus aureus and *Esherichia coli* are found in the human body. *S. aureus* is on skin and *E. coli*, in the large intestine.

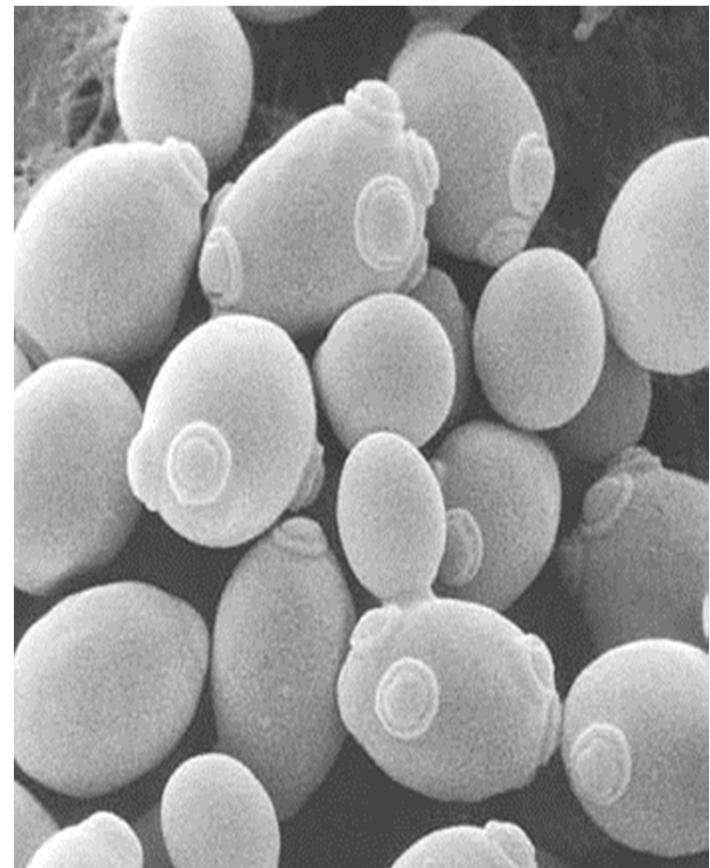
Fungi

- Yeast are important microbes too!
- Yeasts are classified in the **Fungus** kingdom
- Over 1.5 million species estimated to exist
- Only 10% identified & classified
- Fungi are important sources of antibiotics and blood cholesterol-lowering drugs.

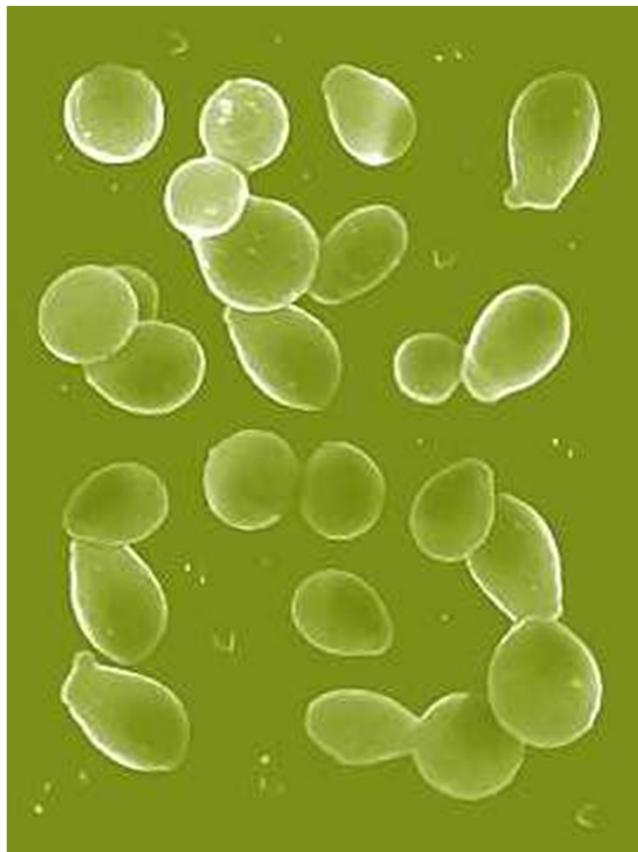


Yeast

- Yeast cells are generally larger in size and have larger genomes than most bacteria
- Mechanisms of gene expression in yeast resemble those in human cells (*valuable **model organism***)
- Several human disease genes have been discovered in yeast.
- Can grow in the presence of oxygen (**aerobic**) or in the absence of oxygen (**anaerobic**)
- Many different types of yeast mutants are available

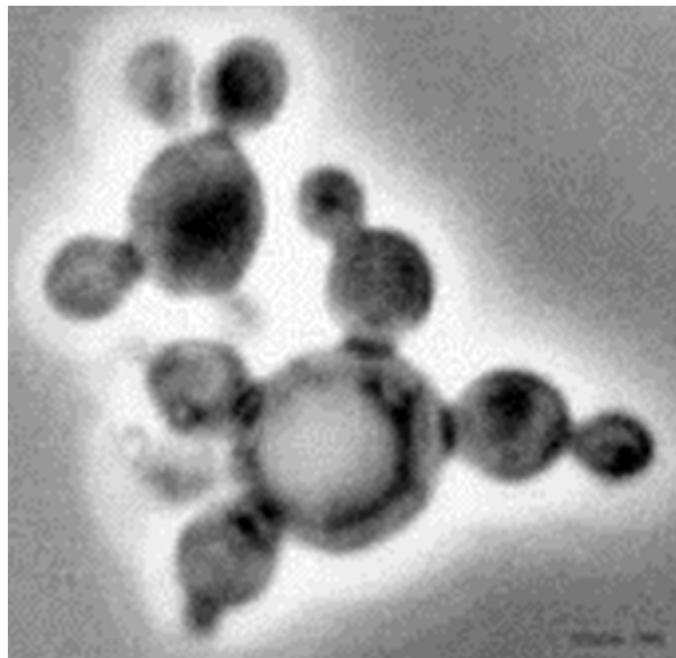


Saccharomyces cerevisiae



- Commonly studied strain of yeast
- Microorganism behind the most common form of fermentation
- 1st *eukaryotic* organism to have its complete genome sequenced
- 16 linear chromosomes
- 12 million base pairs
- ~ 6,300 genes

Pichia pastoris



- Similar to *S. cerevisiae*
- Grows to a high biomass in liquid culture
- Valued for high growth rate and ability to grow on simple, inexpensive media
- Frequently used as an expression system for protein production
- Can be used in batch processes to produce large numbers of cells

