

version: 09/15/20

DON'T
PANIC

Recorded Review for Unit One

Chapter 01: The Main Themes

Chapter 03: Tools of the Lab

Chapter 04: Bacteria and Archaea

Chapter 05: Eukaryotic Cells

Chapter 06: Viruses and Prions

Sixth Edition

Microbiology

A Systems Approach



Mc
Graw
Hill

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Heidi Smith

Chapter 1

The Main Themes of Microbiology

Naming, classifying, and identifying organisms

- **Taxonomy:** the science of identifying, classifying, and naming biological species - a term attributed to Carl von Linné in the 1700s
- **Classification:** attempts the orderly arrangement of organisms into a hierarchy of taxa (i.e. categories)
- **Identification:** process of discovering and recording the traits of organisms so they can be recognized or named and placed in a taxonomic scheme
- **Phylogeny:** the taxonomic scheme that represents the natural relatedness (evolutionary relationship) between groups of living things

This can all get very confusing, very fast. Try thinking about these terms this way:

Phylogeny is a form of **identification** that allows scientists to **classify** an organism into a **taxonomic** category based upon its evolutionary relatedness to other organisms.

Taxonomy is the science that uses **identification**, **classification**, and **phylogeny**.

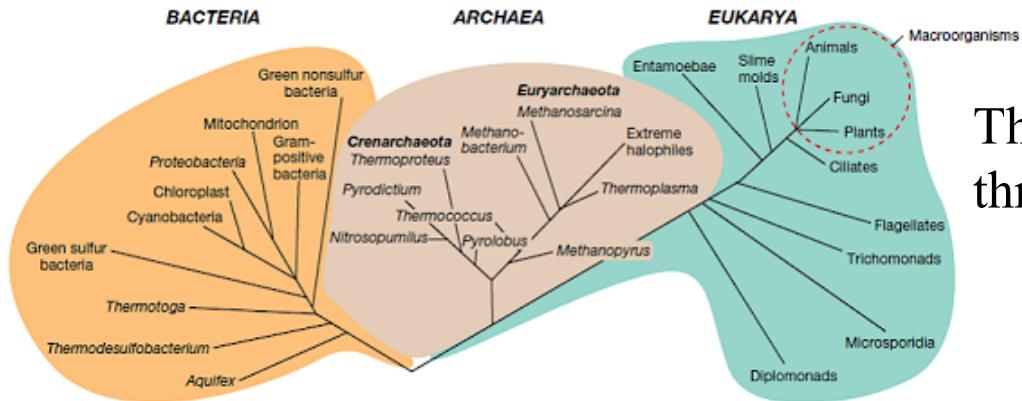
And I highly recommend the following video: [Classification - by the Amoeba Sisters](#)

15. Draw a diagram of the three major domains.

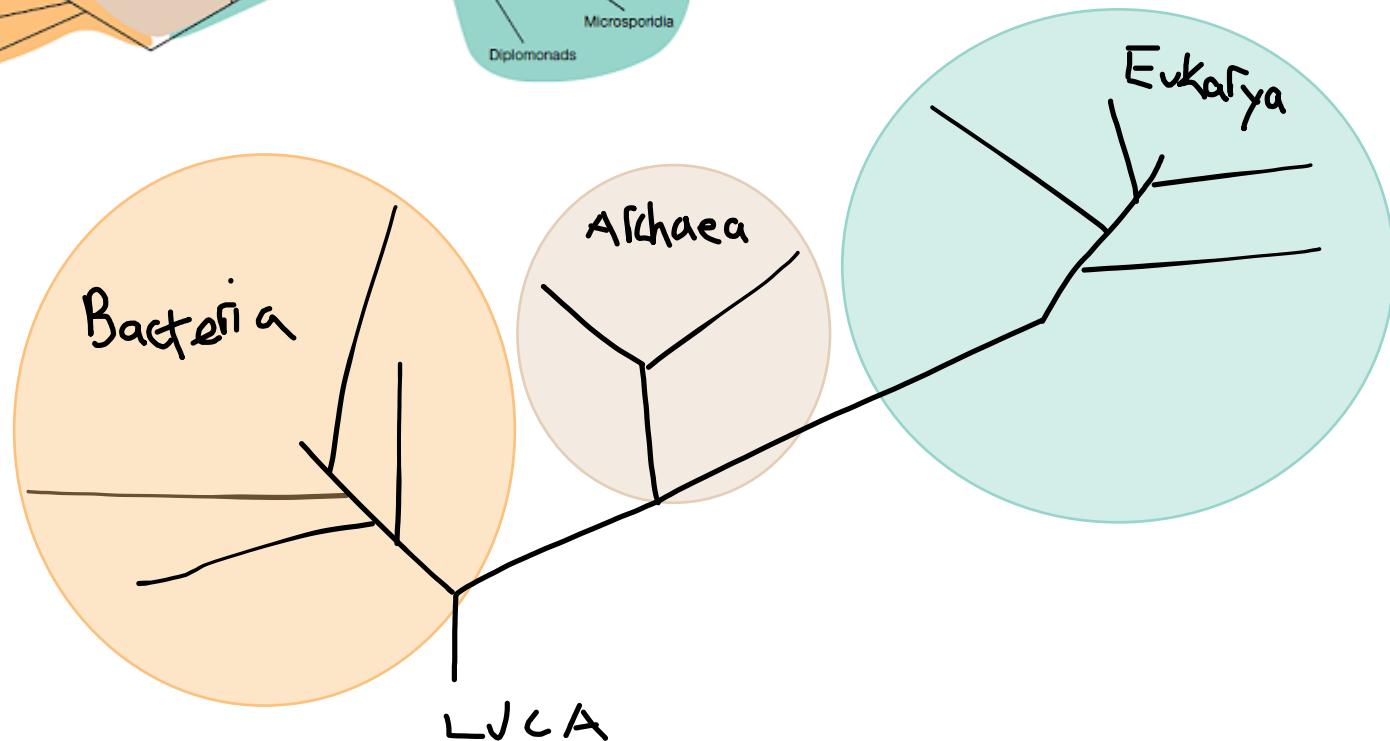
Chapter 1

Outcome 15

or use Figure 1.12
from your book



The modern
three domain tree



Domain



Kingdom



Phylum



Class



Order



Family



Genus



Species

Taxonomic levels of classification

gif credit: [Amoeba Sisters](#)

To view the relevant gif:
[click here](#)

This gif is not necessarily information dense,
but I find it beautiful nonetheless

- The taxonomic hierarchy on the left starts from the broadest category at the top and flows downward to gradually become more specific

Domain



Kingdom



Phylum



Class



Order



Family



Genus



Species

Eukarya

Plants!



Domain
↓
Kingdom
↓
Phylum
↓
Class
↓
Order
↓
Family
↓
Genus
↓
Species

Animalia



One of our shrimp
with eggs (yellow).
The black dots in
the eggs are baby
shrimp eyes!
Nature is magical!

Domain
↓
Kingdom
↓
Phylum
↓
Class
↓
Order
↓
Family
↓
Genus
↓
Species

Chordata

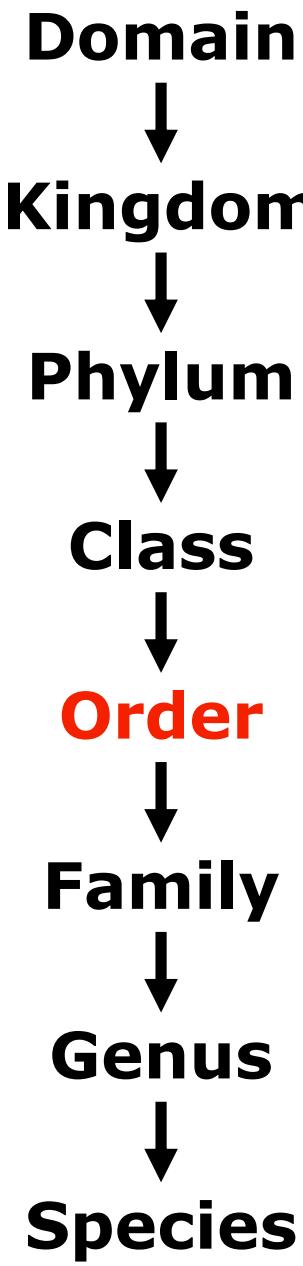


One of our
pygmy catfish -
aptly "catting"
on that leaf

Domain
↓
Kingdom
↓
Phylum
↓
Class
↓
Order
↓
Family
↓
Genus
↓
Species

Mammalia





Primates



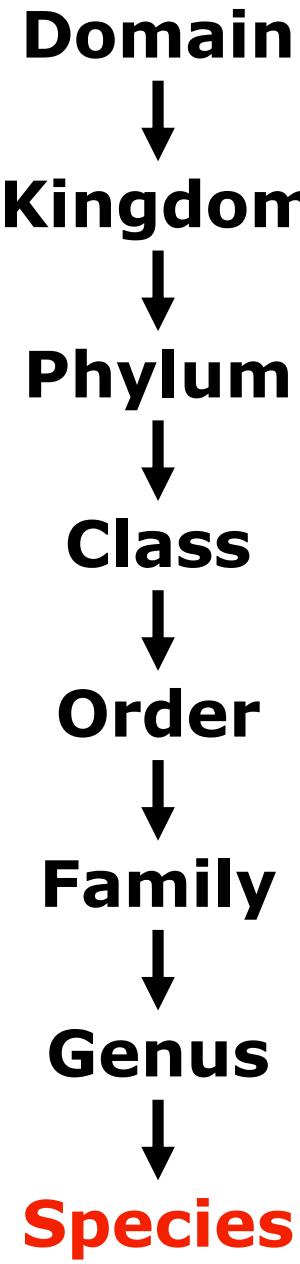
Lar Gibbon!



Domain
↓
Kingdom
↓
Phylum
↓
Class
↓
Order
↓
Family
↓
Genus
↓
Species

Hominidae





Homo sapiens

Modern humans are the sole surviving species of the *Homo* genus.

Kristina! (my partner).
This is the cover of our debut hip-hop album
Drops Kristmas Day



Nomenclature: Assigning Specific Names

- Binomial system (i.e. binomial nomenclature):
 - A combination of the genus name and the species name
 - Always capitalize the genus name - the species name is lowercase
 - Both names are *italicized* in print or underlined when hand-written

To view the relevant gif:

[click here](#)

gif credit:
[Amoeba Sisters](#)

Chapter 3

Tools of the Laboratory

VARIATIONS ON THE LIGHT MICROSCOPE

Four types of light microscopes:

Bright-field

Dark-field

Phase-contrast

Interference

Fluorescence microscope: uses ultraviolet radiation as the illuminating source

Confocal microscope: uses a laser beam as the illuminating source

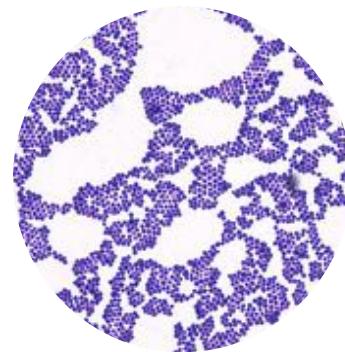
7. Differentiate between the principles of light and electron microscopy

Chapter 3

Outcome 7

Light Microscopy = \$\$\$ to\$\$\$\$\$

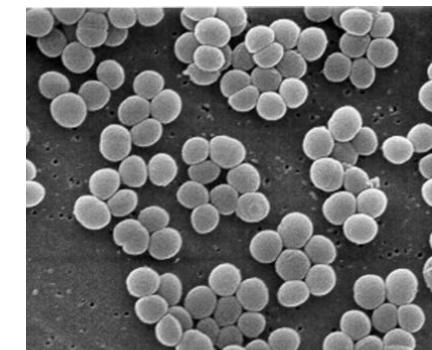
- illumination using light beam
- magnification up to 1500X (typically)
- low resolving power
- specimen prep takes minutes to hours
- can visualize living or dead specimens
- staining can produce color images that also carry useful information



Staphylococcus aureus
at 100X

Electron Microscopy =\$\$\$\$\$\$\$

- illumination using electron beam
- magnification up to 300,000X
- high resolving power
- specimen prep takes hours to days
- can only visualize dead specimens
- produces only black and white images (we often “false-color” them)



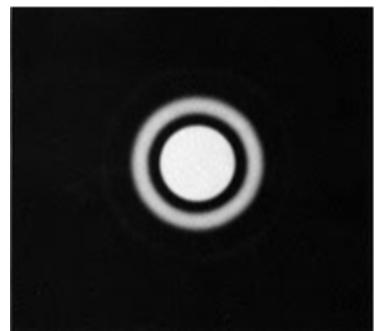
Staphylococcus aureus
at 10,000X

Quick note on the term: **Resolving power**

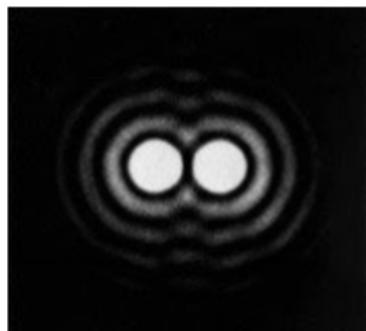
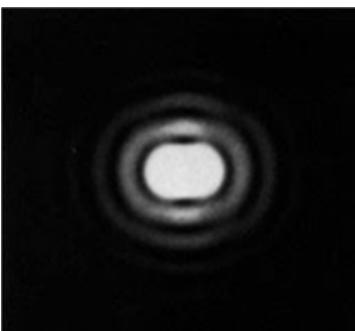
Think of **resolving power** as the ability to distinguish between two adjacent objects or structures. If your microscope has *high resolving power* then you are able to visualize both objects. If your microscope has *low resolving power* then both of those objects will be seen as a single merged object.



low
resolving
power

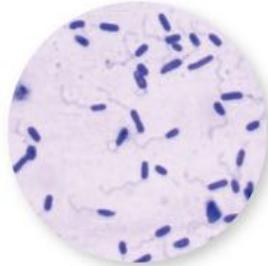


high
resolving
power



Basic types of staining techniques

- **Positive stain:**



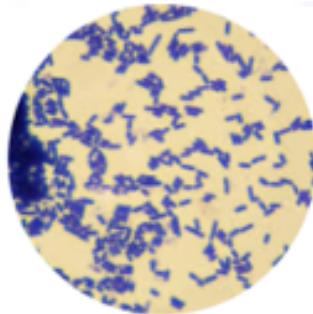
- basic dyes carry a positive charge (also called cationic)
- attracted to acidic, negatively charged cell walls
- stick to the cell and give it color

- **Negative stain:**

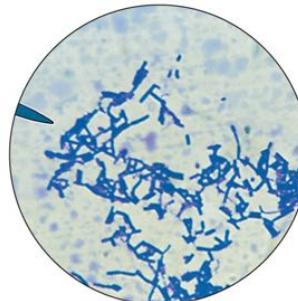


- acidic dyes carry a negative charge (also called anionic)
- repelled by acidic, negatively charged cell walls
- create a dark background surrounding the cell

Methylene blue



Crystal violet



Classifications

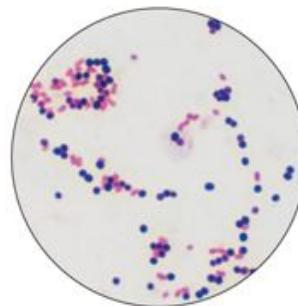
Chapter 3

Simple Stains: A single basic dye is used to add color to cells. This technique tends to color all cells the same color.

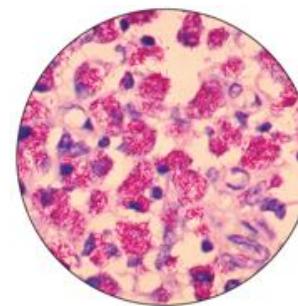
Differential Stains:

Two dyes are used to distinguish between different microbial groups, cell types, or cell parts via contrasting colors.

Gram Stain



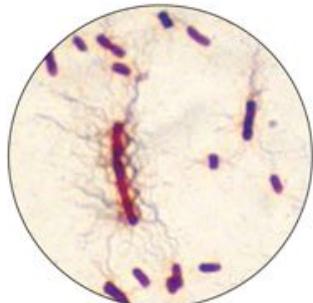
Acid Fast Stain



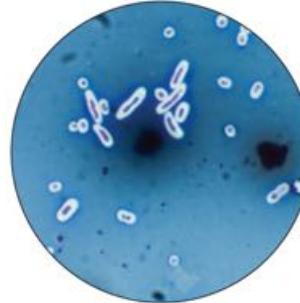
Endospore Stain



Flagellar Stain



Capsule Stain



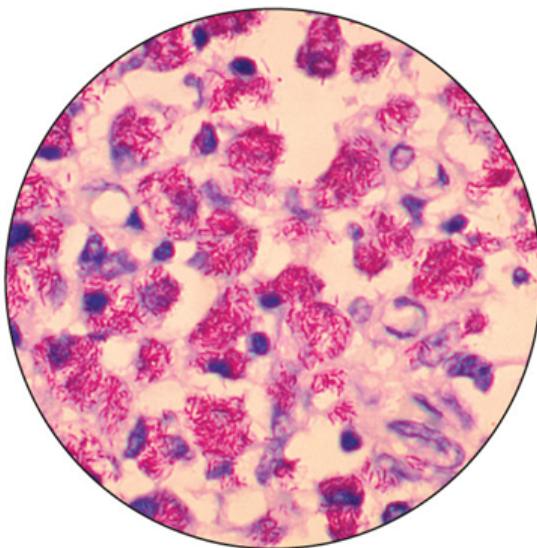
Note: The capsule stain can also be differential

Special Stains: Dyes are used for specific purposes, such as to look at different structures (e.g. capsules, flagella). There are many types!

Differential Stains:

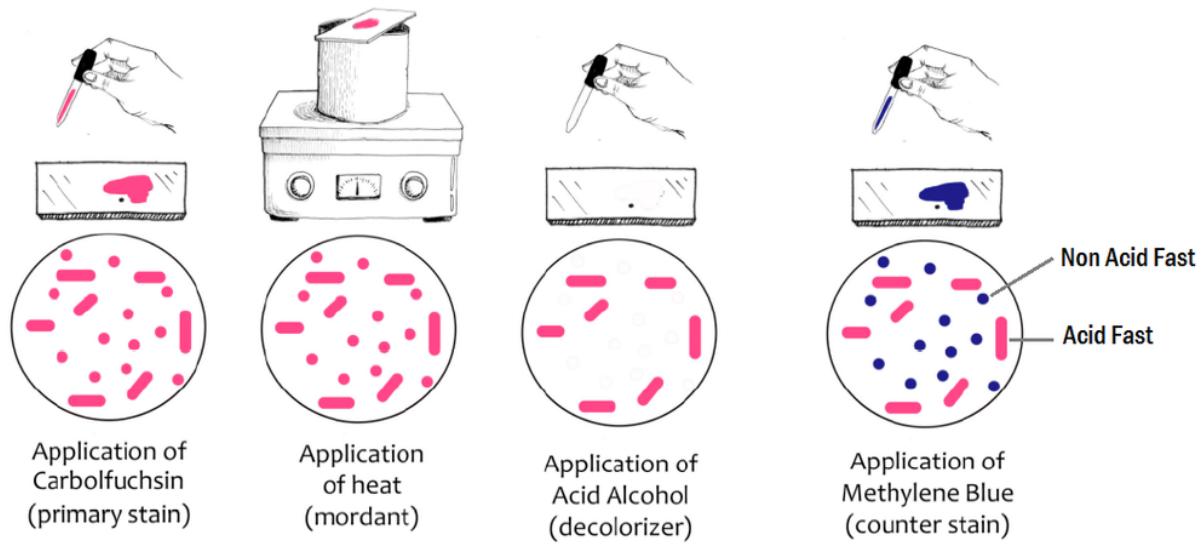
Two dyes are used to distinguish between different microbial groups, cell types, or cell parts.

Acid Fast Stain



Also called the Ziehl-Neelsen stain, the Acid-Fast Stain differentiates acid-fast bacteria from nonacid-fast bacteria.

Used as a preliminary, quick diagnostic to detect the agents of tuberculosis (*Mycobacterium tuberculosis*) and leprosy (*Mycobacterium leprae*)



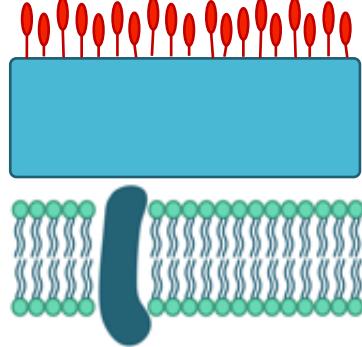
Acid-fast = pink cells

Nonacid fast = blue-ish cells

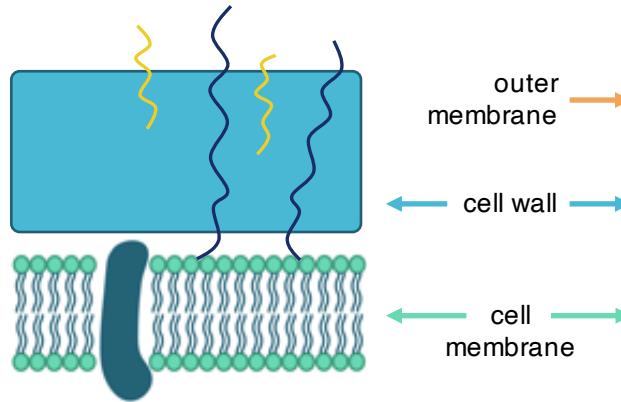
Acid-fast bacteria have high abundance of mycolic acids - which are substances found in the cell envelope that can confer pathogenicity and cause major symptoms in humans (one possible answer for Chapter 4 outcome 10).

Bacterial cell envelopes

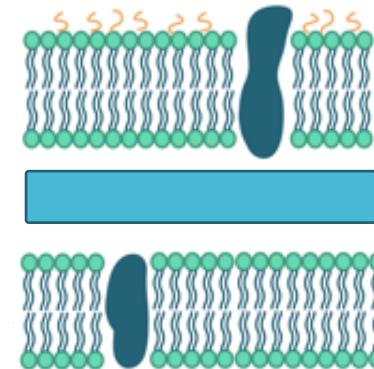
Acid-fast



Gram-positive



Gram-negative



Acid-fast bacteria are characterized by the presence of mycolic acid in their envelope.

Although their envelope resembles that of Gram-positive bacteria, the waxy properties of mycolic acid essentially block the crystal violet from staining their cell walls. So, we use a different staining procedure for acid-fast bacteria.

Mycolic acid

Teichoic acid

Lipoteichoic acid

Lipopolysaccharide (LPS)

Phospholipid bilayer

Peptidoglycan (i.e. cell wall)

Membrane proteins

Differential Stains:

Two dyes are used to distinguish between different microbial groups, cell types, or cell parts.

Endospore Stain

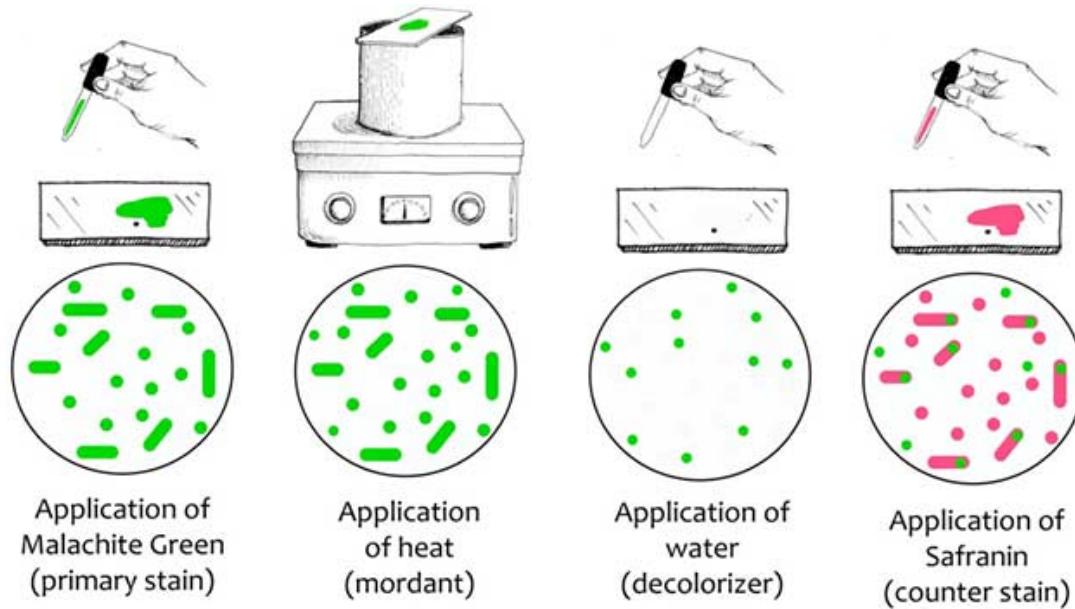


Endospores = green ovals

Vegetative cells = pink cells

The Endospore stain is used to detect endospore-forming members of the genera *Bacillus* & *Clostridium*

The Schaeffer-Fulton staining procedure is depicted below.



Endospores are protective structures allowing bacteria to survive extreme conditions (i.e. environmental stress) including lack of nutrients, desiccation/drought, UV radiation, high temperatures and extreme freezing, chemical disinfectants, and even antibiotics.

Chapter 4

Bacteria and Archaea

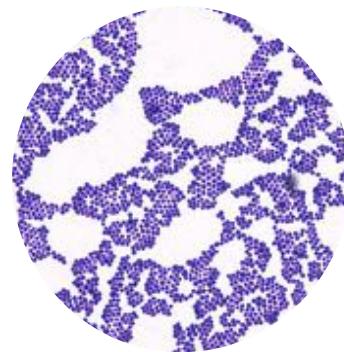
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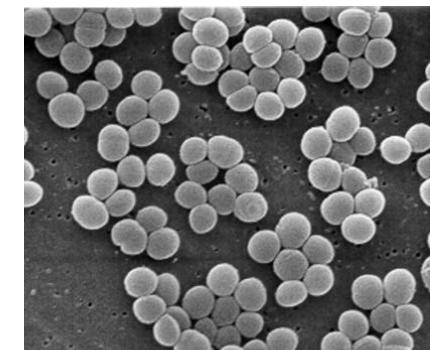
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Staphylococcus aureus
at 10,000X

Surface coatings

- In response to harsh or hostile environments, bacteria can produce surface coatings to protect themselves. There are two types of surface coatings:

S layer

- thousands of copies of a single protein linked together
- only produced in hostile environments

Tip:

Think of the S layer as chainmail surrounding a bacterial cell - the metal chains are the thousands of copies of proteins OR use the book's example of a chain-link fence.



Glycocalyx

- often occur as repeating polysaccharide (sugar) units that may or may not include protein
- highly variable in chemical composition, thickness, and organization
- some glycocalyses help bacteria adhere to surfaces while others help bacteria communicate with one another
- The two primary types your book discusses are:
 - **Slime layers**
 - **Capsules**

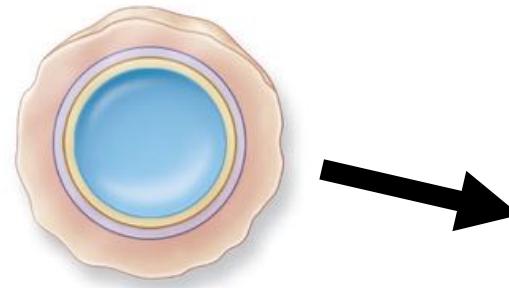
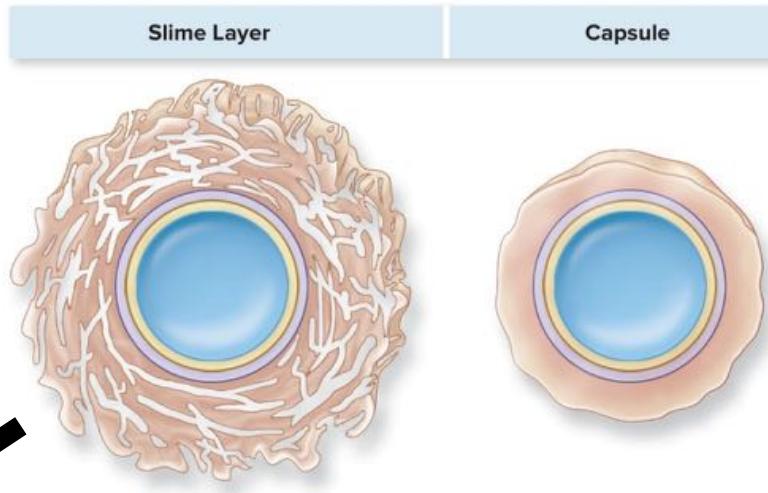
Two types of glycocalyx



- The slime layer is a loose shield that protects the cell from losing water and nutrients.

Tip:

Like a knight's shield the slime layer is easily removed from bacteria.



- Capsules are thick and tightly bound to the bacterial cell
- Often formed by pathogenic bacteria and confer protection from phagocytosis allowing capsule forming bacteria to evade the host immune system.

Tip:
capsules are
space suits for bacteria.

Space suits protect
humans from the harsh
environment of space...

Capsules protect bacteria
from the harsh
environment of the
human body...



Check out these Amoeba Sisters videos that discuss material related to Chapter 4

- [Bacteria \(Updated\)](#)
- [Archaea](#)

Chapter 5

Eukaryotic cells

Check out these Amoeba Sisters videos that discuss material related to Chapter 5

- [Prokaryotic vs. Eukaryotic Cells \(Updated\)](#)
- [Protists and Fungi](#)

Chapter 6

Viruses and prions

Lifestyles of the viral and infectious

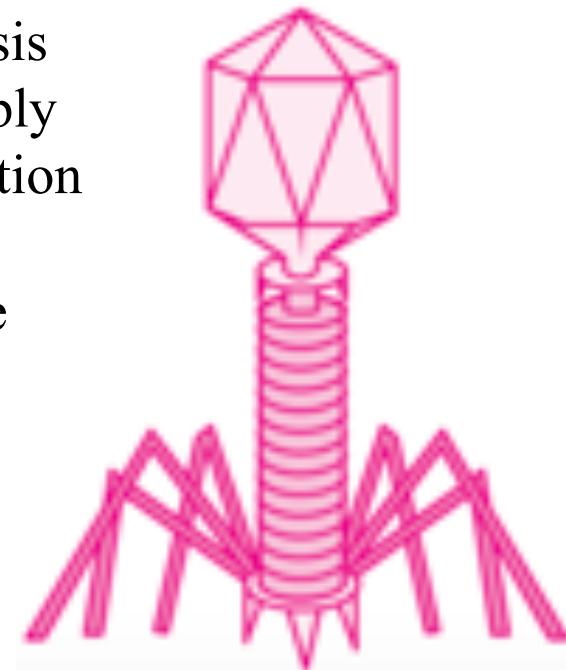
Animal viruses



1. Adsorption
2. Penetration
3. Uncoating
4. Synthesis
5. Assembly
6. Release

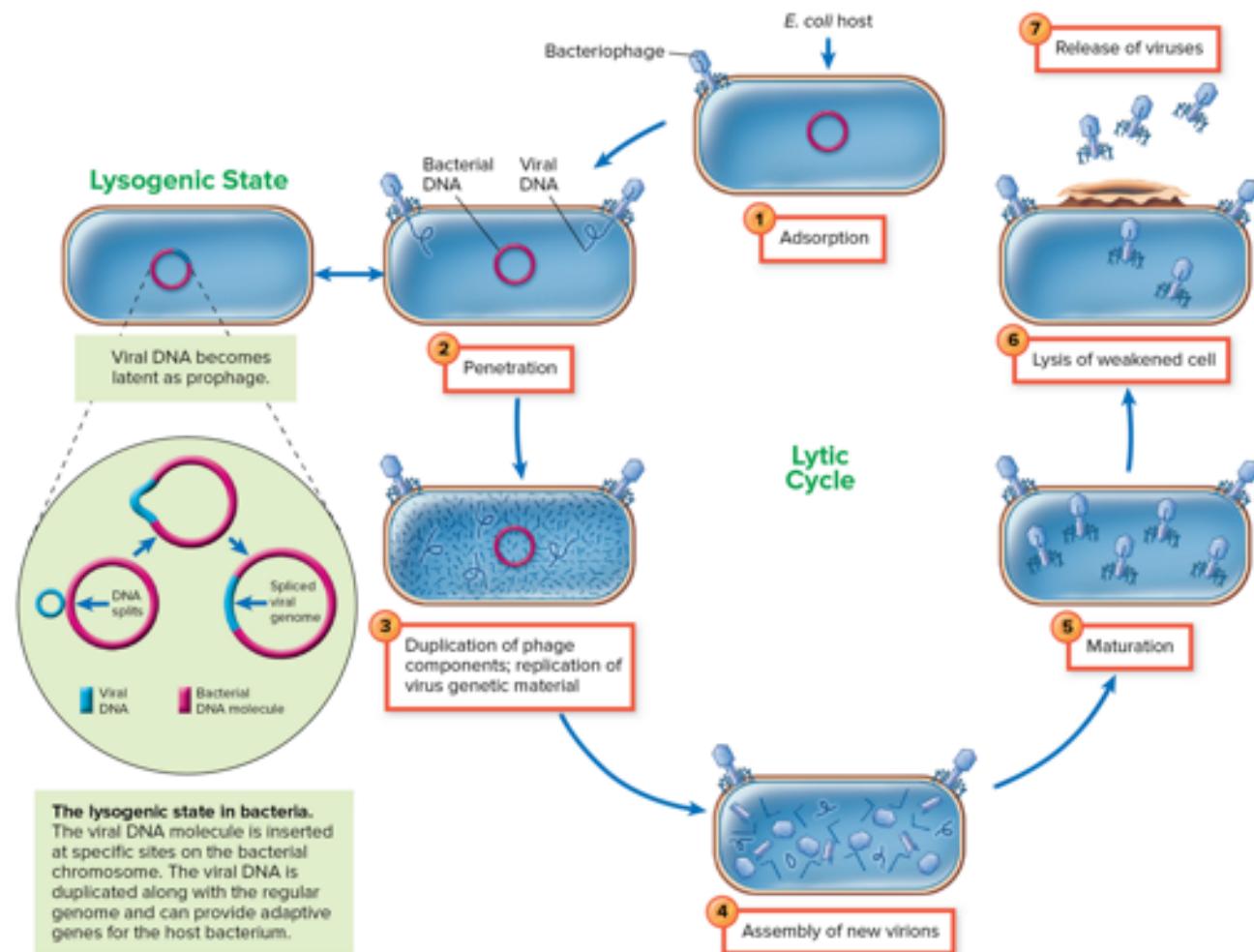
Bacteriophages

1. Adsorption
2. Penetration
3. Synthesis
4. Assembly
5. Maturation
6. Lysis
7. Release



The secret life of bacteriophages

1. Adsorption
2. Penetration
- *choose your own adventure: *lytic?* or *lysogenic?**
3. Synthesis
4. Assembly
5. Maturation
6. Lysis
7. Release



Check out these Amoeba Sisters videos that discuss material related to Chapter 6

- [Viruses \(OLD VIDEO\)](#)
- [Viruses \(Updated\)](#)

The Khan Academy is also an excellent resource for any of the material covered in this class. Here's a link to their page discussing the lifestyles of bacteriophages

- [Bacteriophages](#)