# INTRODUCTION TO MICROBIOLOGY

**CHAPTERS 1, 3, & 9 (PGS. 240-253)**

CH 1

Unit 1 Objectives:

1. Describe current microbiological research practices.
2. Describe the 5 major types of microbes.
3. Explain taxonomy and scientific naming.
4. Describe different types of stains and microbial preparation for microscope viewing.
5. Identify and use the light microscope.

2

## Microbiology 101

- SO…what is microbiology?
- What is a microbe?
- 2 dimensions of microbiology:
  1. Types of microbes
  2. What microbiologists do

3

## Roles of Microbes

- Pathogens
- Food chain
  - Autotrophs
  - Decomposers
- Digestive
- Foods and fermentation
- Antibiotics
- Biotechnology
- Bioremediation
- Disease Research

## Why Use Microbes in Research?

1. Size/ Structure
2. Large populations
3. Rapid Growth Rate
4. Research Benefits
   - Vaccines
   - Antibiotics

## Health-Related Fields of Study

- Immunology
- Epidemiology
- Etiology
- Bioremediation

David Parker/Photo Researchers, Inc.

## Fields of Study using Application

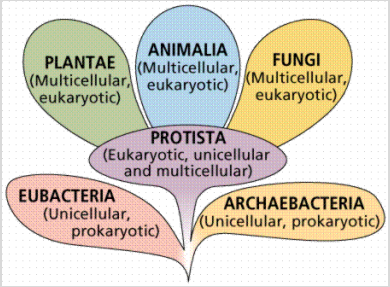
- Infection Control
- Chemotherapy
- Industrial Microbiology
- Biotechnology

## Brain Check…

1. How can microorganisms be beneficial?
2. What is the difference between epidemiology and etiology?
3. Name 5 bacterial diseases.
4. Name 5 viral diseases.

## Terms to know

- Prokaryotic: **cells WITHOUT a nucleus**
- Eukaryotic: **cells WITH a nucleus**
- **Autotroph**: organisms that produce their own food using sunlight
- **Chemotroph:** organisms that consume inorganic or organic substances for nutrition
- **Heterotroph**: organisms that have to consume other organisms for food (carnivores, omnivores, herbivores)




## Overview of Microbes

1. Viruses

2. Prokaryotes—NO NUCLEUS
   - Unicellular (single-celled)

3. Eukaryotes—HAVE A NUCLEUS
   - Unicellular & multicellular, (many-celled)

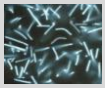
Kingdom: Archaebacteria

Cell type:
prokaryotic

Unicellular/Multicellular:
All unicellular

Mode of Nutrition:
Autotrophic, Chemoautrophic, & Heterotrophic

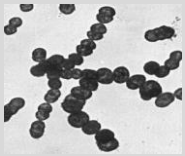
Examples:
**Methanogens, thermophiles, & halophiles (extreme environments)**



*Methanogenium frigidum*

*Thermus aquaticus*

*Haladaptatus litoreus*



Streptococcus pyogenes

## Kingdom: Eubacteria

Cell type :
prokaryotic

Unicellular/Multicellular:
All unicellular

Mode of Nutrition:
Autotrophic, Chemoautrophic, & Heterotrophic

Examples:
**Streptococcus & Mycobacterium (common bacteria that live everywhere else)**

Paramecium

Amoeba

Euglena

## Kingdom: Protista

Type of cells:
eukaryotic

Unicellular/Multicellular:
most unicellular

Mode of Nutrition:
Heterotrophic & Autotrophic

Examples:
**Amoeba, Euglena, Paramecium**

## Kingdom: Fungi

Type of cells:
eukaryotic

Unicellular/Multicellular:
Mostly multicellular

Mode of Nutrition:
Heterotrophic

Examples:
**Mushroom, yeast, molds**

Mushroom

Yeast

Molds

## Kingdom: Animalia

Type of cells:
eukaryotic

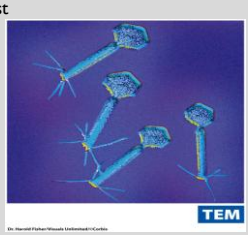
Unicellular/Multicellular:
multicellular

Mode of Nutrition:
Heterotrophic

Examples:
**Arthropods (insects) & Helminths (worms)**

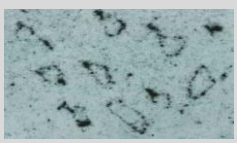
## Viruses

- Nonliving because it doesn't display characteristics of life until it has a host
- Simple structure
  - Capsid
  - Nucleic acid
- Smaller relatives
  - Viroids
  - Prions



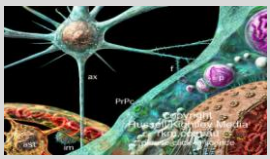

## Microbes: Other Non-living Infectious Agents

- **Viroid**—smallest known particle that can cause infections
  - Circular, single strands of RNA
  - No capsid (no protein coat)



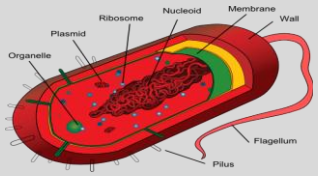
## Microbes: Other Non-living Infectious Agents

- **Prions**—proteins that do not have any nucleic acids, but instead cause other proteins to fold incorrectly.
  - responsible for many animal diseases like mad cow disease and the human equivalent Creutzfeldt-Jakob disease.
  - ex. Kuru—occurred in many tribal places



## Prokaryotes

- Structure
  - No nucleus
  - Organelles
  - Cell wall (optional)
- Two Kingdoms:
  - Archaebacteria
  - Eubacteria



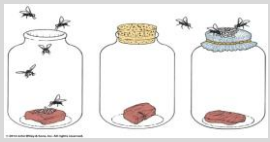

## Eukaryotic Parasites

- Protists
  - Ex. amoeba
- Fungi
- Animals:

1. Helminths
   - Ex. Worms (flat, round, & segmented)
2. Arthropods
   - Ex. Ticks, insects, fleas
   - Cause/transmit disease in their microscopic stages or as carriers


## Spontaneous Generation versus Biogenesis

- Definitions
- Redi
- Spallanzani
- ? Role of oxygen
- Pasteur
  - Biogenesis wins!
  - Fermentation
  - Pasteurization



## Germ Theory

- Theory definition:
  - Microorganisms can invade other organisms and cause disease
- Important Contributors:
  - Koch
  - Semmelweiss
  - Lister
  - Jenner
  - Pasteur

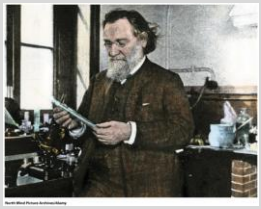
## Koch's Postulates

1. The bacteria must be present in every case of the disease.
2. The bacteria must be isolated from the host with the disease and grown in pure culture.
3. The specific disease must be reproduced when a pure culture of the bacteria is inoculated into a healthy susceptible host.
4. The bacteria must be recoverable from the experimentally infected host.

## Please Wash Your Hands!!!

- **Semmelweiss**: work demonstrated that hand-washing could drastically reduce the number of women dying after childbirth
- **Joseph Lister**: father of aseptic technique in surgery

## Immunology



- **Edward Jenner**
  - pioneer of smallpox vaccine, the world's first vaccine.
  - "the father of immunology"
- **Louis Pasteur**
  - Pasteurization
  - Rabies vaccine

## Future Trends

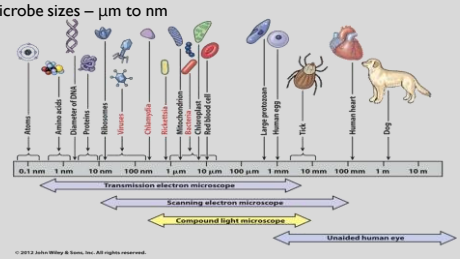
- Recombinant Microbes
  - Drugs
  - Hormones
  - Vaccines
- Gene therapy
- Bacteriophage therapy
- Genomics

## MICROSCOPY & STAINING

CH 3

## Metric Units

- Microbe sizes – μm to nm






## History of the Microscope

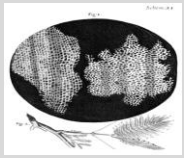
- Microscope Development
  - Robert Hooke
  - Anton van Leeuwenhoek

## History of the Microscope

**Robert Hooke**

- Used the compound microscope to study cork and came up with the name "cells"

He drew this with a QUILL pen…real talk!



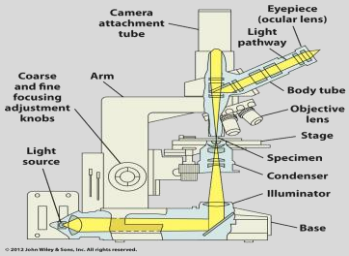
## History of the Microscope

**Anton von Leeuwenhoek**

- First person to witness (and record) looking at a live cell under a microscope…called them **animacules**
- He made over 500 different types of microscopes
- ***FYI:*** *It contained one lens and used only natural light to view objects*

## Compound Light Microscopy

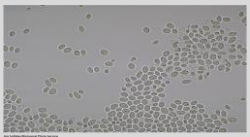
- Condenser
- Iris diaphragm
- Objective lenses
- Ocular lens(es)
  - Monocular or binocular
- Stage
- Focusing knobs
- Total Magnification

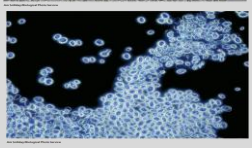





## Light Microscopy Types

- Condenser controls the amount of light a specimen receives
- **Bright Field**
  - Light passes through the microorganisms
- Dark Field
  - Light-sensitive microorganisms
  - Lack contrast with a bright field
  - Light reflects off of the specimen at an angle





## Dual Beam Microscopy

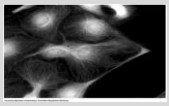
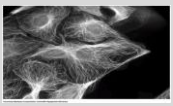
- Phase Contrast
  - for organisms that would be killed by stains
  - Changes the speed of light so that you have different degrees of brightness
- Nomarski
  - Uses a higher resolution to make an almost 3D picture

## Fluorescence Microscopy

- Uses ultraviolet light
- Natural fluorescence (yellow or orange) versus **flouorochromes** (dyes that bind to nucleic acid & show up on a dark background)
- **FAb staining**: diagnostic process using flouorochromes to tag Ab for the suspected antigen that are then added to a sample of blood or sputum…if the antigen is present,Ab + antigen = positive diagnosis

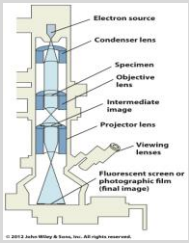
## Imaging Techniques

- Confocal Microscopy (UV):
  - Uses laser light to thin sections through a specimen with 40x greater resolution
- Digital Microscopy:
  - uses computer techniques to automatically focus, , adjust light, and take pictures that can be saved and uploaded

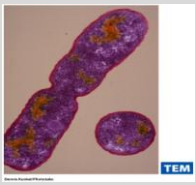




## Electron Microscopy (EM)

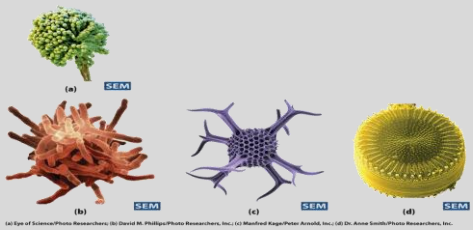
- Source of magnification: **electrons (up to 500,000X)**
- Transmission (TEM):
  - Reveals the internal structures in a **2D** image
- Scanning (SEM):
  - Reveals the surface structures for a **3D** image




## EM Images



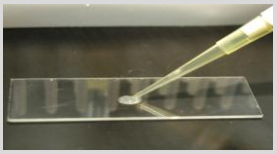

## EM Images



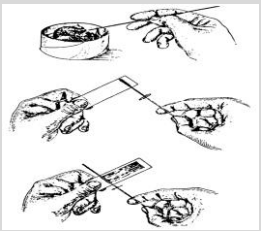

(a) Eye of Science/Photo Researchers; (b) David M. Phillips/Photo Researchers, Inc.; (c) Manfred Kage/Peter Arnold, Inc.; (d) Dr. Anne Smith/Photo Researchers, Inc.

## Light Microscope Specimen Preparation: **Wet Mounts**

- Wet Mounts
  - Helps show motility in microorganisms
  - Shows if specimen are even present
  - fresh cultures must be used for maximum motility
  - NO STAINS!!



## Light Microscope Specimen Preparation: **Smears**



- Allow you to apply stains (dye) to cells which are usually colorless
- Steps:
  1. Placement of cells
  2. Air drying
  3. Heat fixation (flame or warmer)
  4. Apply stain

## Staining Principles

- What is a stain?
  - A stain, or dye, is a molecule that can bind to cellular structure and give it color…because cytoplasm is clear
- Why do we use them?
  1. To help investigate major groups
  2. Examine structural and chemical differences in cells
  3. Look at parts of the cell

## Staining Principles

Basic stains:
- most commonly used
- positively charged or *cationic*
- Most cell membranes are negatively charged
- Ex. Methylene blue & crystal violet

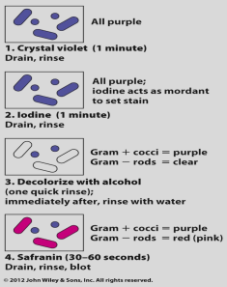
Acidic stains:
- Attracted to certain cell parts
- Ex. Eosin (dark red) & picric acid (yellow)

## Staining Principles

1. Simple Stains:
   - Uses a single dye
   - Reveals basic cell structures and arrangements
   - Ex. Methylene blue, crystal violet, & carbolfuchsin
2. Differential Stains: Gram & Ziehl-Neelsen
   - Using 2 or more dyes
   - Distinguishes between 2 kinds of organisms or 2 different parts of it
3. Special Stains: Negative, Flagellar, & Endospore

## Gram Stain

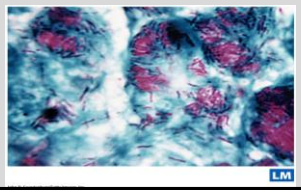
- Technique
- Significance
  - Cell wall anatomy
  - Diagnosis





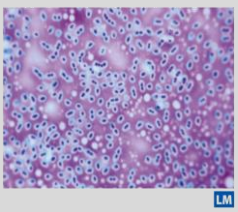
## Ziehl-Neelsen Acid Fast Stain

- Acid Fast Bacteria
  - *Mycobacterium* (tuberculosis & leprosy)
  - Stain red because of the lipids in their cell membranes



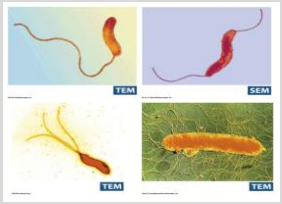

## Negative staining

- Cell Capsule
  - Interferes with the ability to accept the stain so you stain the background dark and the cells show up



## Flagellar staining

- Motility
- Metal staining
- It's difficult so don't worry about doing it ☺



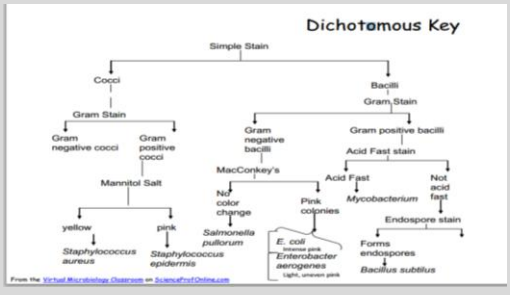

## Endospore staining

- Heat-resistant endospores
- **Schaeffer-Fulton** stain
- Medical significance

## Tools of Classification

## Tools of Classification: **Dichotomous Keys**

- Aid in identifying unknown organisms
- Pairs of statements with two choices of characteristics
- This will lead to another pair of characteristics..and so on…
- Only one choice will apply to the unknown organism




**Levels of Classification**
**(Taxonomic Categories – Taxa)**

1. Domain "Most broad"
2. Kingdom
3. Phylum (Division for plants)
4. Class
5. Order
6. Family
7. Genus
8. Species "Most specific"

**Write down this Memory Aid:**

1. Did
2. King
3. Phillip
4. Come
5. Over
6. From
7. Great
8. Spain ?

## *Rules for writing scientific names*

1. The **Genus** is written first and the **species** is written second.
   Ex: Homo (Genus) sapiens (species) = Homo sapiens
2. The first letter in the first word (Genus) is capitalized, and the second word is written lower case.
   Ex: Homo sapiens
3. The scientific name must be underlined OR written in italics.
   Ex: Homo sapiens *Homo sapiens*

## Scientific Names...

An organism has only **ONE** scientific name.

common dog

*Canus familiaris*

wolf

Canus lupus

White-tailed deer

Odocoileus virginianus

*Terrapene carolina*

box turtle

Scientists DO NOT use common names of organisms !!!

*Common names are the everyday name of an organism.

Reason #1:
**The names are not very descriptive** (which can be confusing in naming the organisms)

*Lontra canadensis/Enhydra lutris*

*River otter/Sea otter*

Reason #2:
**Some organisms have more than one common name**

English sparrow

House sparrow

Sycamore tree

buttonwood

## Brain Check…

1. In a scientific name, what classification level is capitalized?
2. Why don't scientists use common names?

## Brain Check…

1. What two levels of classification are bigger than phylum?
2. What memory aid can help you remember the levels of classification we currently use?
3. What 2 levels of classification are used in scientific naming?

## Application Questions

- Group assignment/class dicussion next week

## Unit 1 Lab

1. Lab: Introduction to Microscopes (due at the end of class)
2. Lab Report #1: due next week using your lab notebook