BIOL 240: General Microbiology

Spring 2020 Rm. 23-203 W, Jan. 22

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http://accounts.smccd.edu/staplesn/biol240/

1. **Pre-Lab Writeup #1 due today!:** **ALL of Expt. 2.** Be sure to prepare before each Monday's labs (for BOTH Mon. & Wed.)!! ***(What? Why? How? are we doing in the lab?? Hypothesis?)***
2. Pre-lecture slides and study guides available on course website by the night before. ***(Print WISELY!! If you choose to do so..)***
3. **Blue Books/Class Journals will begin TODAY!!**
4. **Study Guides/ Lesson Objectives due NEXT Week WED. in Lab!**
5. ***SMCCD CANVAS:*** Bi-weekly lab quizzes – **Practice Quiz** will be ready soon. Upload reports later on.
   - **https://smccd.instructure.com/**

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OBJECTIVES:

Students should be able to: .....

1. Name and describe the **7 major "groups"** that include **microorganisms**.
2. Diagram and describe how **Louis Pasteur** proved how life truly arises.
3. Describe the work and significance of the discoveries of **van Leeuwenhoek, Pasteur, Jenner, Koch** and **Fleming**.
4. Diagram & describe **Robert Koch's postulates**, and explain their significance to modern medicine and infectious disease.
5. **Ch. 2:** Describe the **6 "Elements of Life",** their relative **electron affinities** and bonding properties, and their roles in biomolecules.
6. Describe how the **Octet Rule** affects chemical bonding, and distinguish between the relative strengths of the **3 main chemical bonds** formed in biomolecules.

❖ ***These questions are your HOMEWORK between classes!!!***

- ***DUE (and/or Study Guide questions) NEXT THURS. at the start of Lab!!***

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1.2) A Brief History of Microbiology

- Ancestors of bacteria were the first life on Earth.
- The first microbes were observed in **1673**.
  - **Van Leeuwenhoek**

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A. The First Observations

- In 1665, **Robert Hooke** reported that living things were composed of "little boxes" or "cells".
  - **Matthias Schleiden** (botanist), **Theodor Schwann** (physiologist) -- **1830's-1840's**……
- In 1858, **Rudolf Virchow** said cells only arise from preexisting cells.

❖ ***Cell Theory****:* All living things are composed of cells, and all cells come from preexisting cells.

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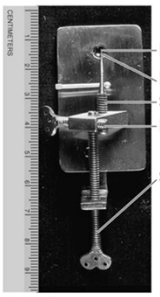
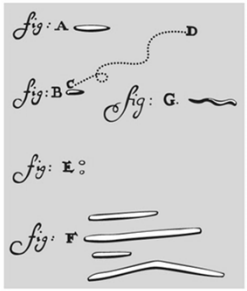
The First Observations

(a) Van Leeuwenhoek using his microscope



(b) Microscope replica



(c) Drawings of bacteria

- 1673-1723 (studies), **Antoni van Leeuwenhoek:**
  - described live microorganisms ("***animalcules***")
  - observed in teeth scrapings, rain water, and peppercorn infusions

Figure 1.2

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B. The Debate Over Spontaneous Generation

- ***Spontaneous Generation:*** the hypothesis that living organisms arise from nonliving matter is called.
  - a **"*Vital Force*"** Forms life. ***(Élan vital)***

- ***Biogenesis:*** Alternative hypothesis, that the living organisms arise from preexisting life.

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Evidence Pro and Con - 1

1) **1668**: **Francesco Redi** filled six jars with decaying meat.

Conditions	**Results**
3 jars covered with fine net	***No maggots***
3 open jars	Maggots appeared
• From where did the maggots come? • What was the purpose of the sealed jars? • *Spontaneous generation or biogenesis?*	

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Evidence Pro and Con - 2

2) **1745**: **John Needham** put boiled nutrient broth into covered flasks.

Conditions	**Results**
Nutrient broth heated, then placed in sealed flask	Microbial growth
• From where did the microbes come? • *Spontaneous generation or biogenesis?*	

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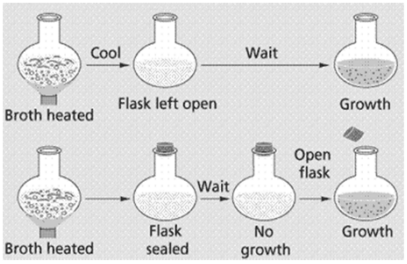
Evidence Pro and Con - 3

3) **1765**: **Lazzaro Spallanzani** boiled nutrient solutions in flasks.



Conditions	Results
Nutrient broth placed in flask, heated, then sealed	***No microbial growth***
• *Spontaneous generation or biogenesis?*	

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Evidence Pro and Con - 4

4) **1861**: **Louis Pasteur** demonstrated that microorganisms are present in the air.
   - *The air itself did not create the microbes/life.*

Conditions	Results
Nutrient broth placed in flask, heated, not sealed	Microbial growth
Nutrient broth placed in flask, heated, then sealed	***No microbial growth***
• ***Spontaneous generation or biogenesis?***	

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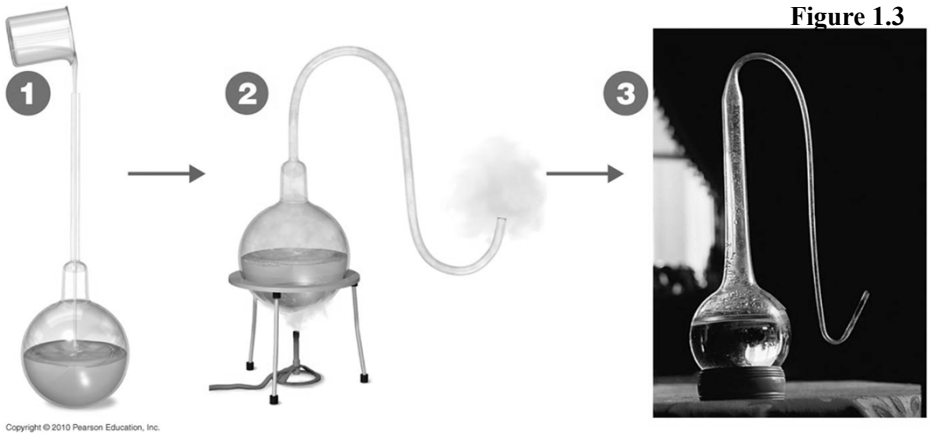
C. The Theory of Biogenesis

- (4b.) Pasteur's **S-shaped ("goose-necked") flask** kept microbes out but let air in.

Figure 1.3



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❖ *What would be a proper CONTROL experiment, to prove these results??*

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1.3) The Golden Age of Microbiology

- ***1857-1914***
- Beginning with Pasteur's work, discoveries included:
  - **Food spoilage** – souring wine and beer
    - Yeast fermentation = causative
  - → the relationship between microbes & disease,
  - **immunity**, and
  - **antimicrobial drugs**

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A. Fermentation & Pasteurization

- Pasteur showed that microbes are responsible for ***fermentation***.
  - Fermentation is the conversion of sugar to alcohol to make beer and wine.
- Microbial growth is also responsible for spoilage of food.
  - Bacteria that use alcohol and produce acetic acid spoil wine by turning it to vinegar (acetic acid).

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Fermentation & Pasteurization

1. **Pasteur** demonstrated:
   - **spoilage bacteria could be killed by heat**
     - a heat not hot enough to evaporate the alcohol in wine.
   - This application of a high heat for a short time is called ***Pasteurization***.

Louis Pasteur (1822–1895)
Demonstrated that life did not arise spontaneously from nonliving matter.

Figure 1.4

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B. The Germ Theory of Disease

2. **1835**: **Agostino Bassi** showed a silkworm disease was caused by a fungus.

3. **1865: Pasteur** produced evidence that another silkworm disease was caused by a protozoan.

4. **1840s**: **Ignaz Semmelweis**
   - advocated *hand-washing* to prevent transmission of *puerperal fever* from one OB patient (mother) to another.
     - *Streptococcus pyogenes*

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The Germ Theory of Disease

5. **1860s**: **Joseph Lister** used a chemical disinfectant to prevent surgical wound infections
   - after looking at Pasteur's work showing microbes are in the air, can spoil food, and cause animal diseases.

6. **1876**: **Robert Koch** provided proof that a bacterium causes anthrax and provided the experimental steps,

❖ ***Koch's postulates***: used to prove that a specific microbe causes a specific disease.
   1. *Find microbe present in every case of the disease;*
   2. *Isolate pure organism from sick host animals;*
   3. *Inoculate organism into healthy host → get disease;*
   4. *Reisolate pure organism from newly/expt'l sick animals.*

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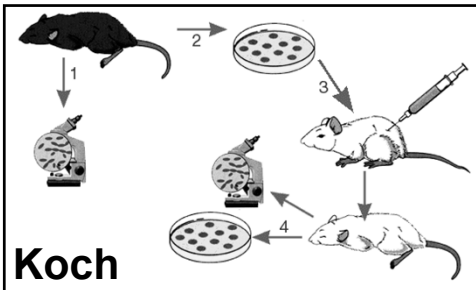

Koch

Jenner

C. Vaccination

7. **1796**: **Edward Jenner** inoculated a person with cowpox virus. The person was then protected from smallpox.
   - Called ***vaccination*** from *vacca* for cow
   - The protection is called immunity

http://www.nlm.nih.gov/exhibition/smallpox/sp_vaccination.html

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D. The Birth of Modern Chemotherapy

- Treatment with chemicals is ***chemotherapy***.
  - Chemotherapeutic agents used to treat infectious disease can be synthetic drugs or antibiotics.
- ***Antibiotics*** are chemicals produced by bacteria and fungi that inhibit or kill other microbes.
  - Quinine from tree bark was long used to treat malaria.

8. **1910**: **Paul Ehrlich** developed a synthetic arsenic drug, salvarsan, to treat **syphilis**.
- 1930s: Sulfonamides were synthesized.

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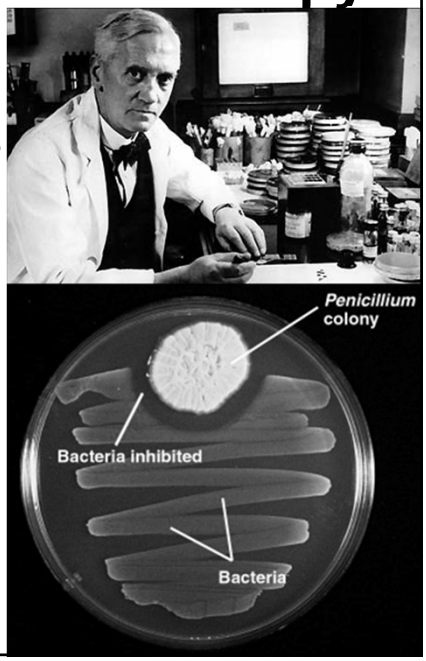
Birth of Modern Chemotherapy

9. **1928**: **Alexander Fleming** discovered the first antibiotic.
   - He observed that ***Penicillium*** fungus made an antibiotic, penicillin,
     - killed ***S. aureus*.**
   - 1940s: Penicillin was tested clinically and mass produced! ……..



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1.4) Modern Developments in Microbiology

- ***Bacteriology*** is the study of bacteria.
- ***Mycology*** is the study of fungi.
- ***Parasitology*** is the study of protozoa and parasitic worms.

- Recent advances in genomics, the study of an organism's genes, have provided new tools for classifying microorganisms.

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Modern Developments: Immunology & Virology

- ***Immunology*** is the study of acquired resistance to disease.
  - Vaccines and interferons are being investigated to prevent and cure viral diseases.
- 1933: **Rebecca Lancefield** proposed the use of immunology to identify some bacteria according to ***serotypes -***
  - (variants within a species = "strains" or "subspecies").
- ***Virology*** is the study of viruses.

Figure 1.4

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1.5) Microbes and Human Welfare

❖ Microbial Ecology

– Bacteria recycle carbon, nitrogen, nutrients, sulfur, and phosphorus that can be used by plants and animals.

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A. Bioremediation

- Bacteria degrade organic matter in sewage.
- Bacteria degrade or detoxify pollutants such as oil and mercury.

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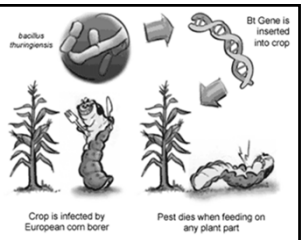
B. Biological Insecticides



- Microbes that are pathogenic to insects
  - alternatives to chemical pesticides
  - prevent insect damage to agricultural crops and disease transmission
- ***Bacillus thuringiensis*** infections are fatal in many insects but harmless to other animals including humans and to plants.

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D. Microbes & Human Disease

- Bacteria were once classified as plants which gave rise to use of the term ***flora*** for microbes.

- This term has been replaced by ***Microbiota***.
  - Microbes normally present in and on the human body are called normal microbiota.

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Normal & Pathogenic Microbiota

1. **Normal microbiota:** prevent growth of pathogens.
   - Normal microbiota produce growth factors such as folic acid and vitamin K.
2. **Resistance:** is the ability of the body to ward off disease.
   - Resistance factors include skin, stomach acid, and antimicrobial chemicals.
3. **Pathogenesis:** When an infectious microbe overcomes the host's resistance, disease results.
   - **Emerging Infectious Diseases (EID):** New diseases and diseases increasing in incidence…….

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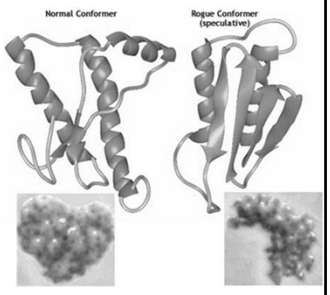
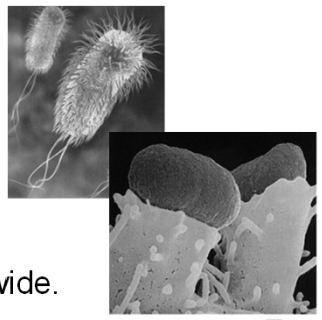
E. Emerging Infectious Diseases



1. **Bovine Spongiform Encephalopathy**
   - **Prion.**
   - Also causes Creutzfeldt-Jakob disease (CJD).
   - New-variant ***CJD*** in humans related to cattle fed sheep offal (entrails) for protein.



2. ***Escherichia coli* O157:H7**
   - Toxin-producing strain of *E. coli.*
   - Fist seen in 1982.
   - Leading cause of diarrhea worldwide.

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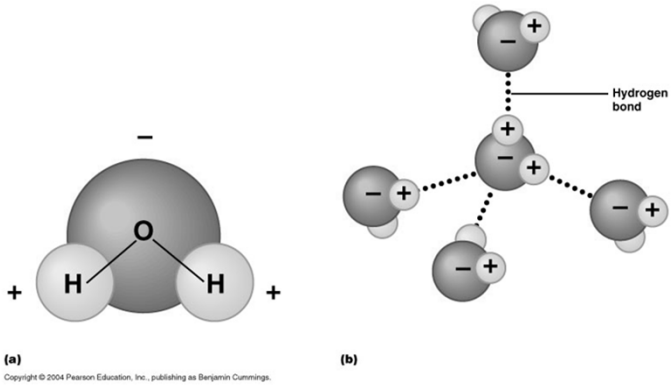
Chapter 2

Chemical Principles



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2.1) Chemistry

- Chemistry is the study of interactions between atoms and molecules.
- The atom is the smallest unit of matter that enters into chemical reactions.
- Atoms interact to form molecules.

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A. The Study of Atoms

Atoms are composed of

- ***Electrons***: negatively charged particles
- ***Protons***: positively charged particles
- ***Neutrons***: uncharged particles

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The Study of Atoms

- Protons and neutrons are in the ***nucleus***.
- Electrons move around the nucleus.
  - ***Electrons carry energy!***
  - ***Electron BEHAVIOR drives chemistry.***

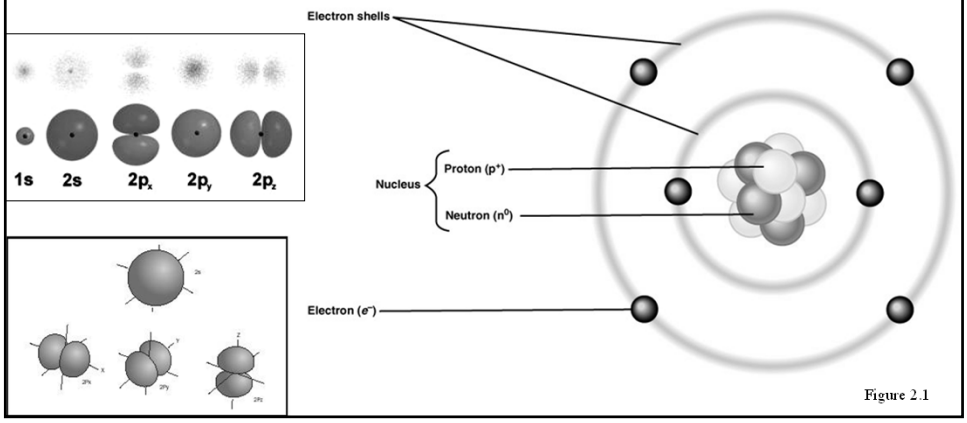

Figure 2.1

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B. Chemical Elements

- ***Each chemical element has a different number of protons.***
- Isotopes of an element are atoms with different numbers of neutrons.
  - Isotopes of oxygen are:

$$^{16}_{8}O \quad ^{17}_{8}O \quad ^{18}_{8}O$$

Mass # **= protons + neutrons**
Atomic # **= protons (identifies element!)**

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CHNOPS!!

TABLE 2.1 **The Elements of Life***

Element	Symbol	Atomic Number	Approximate Atomic Weight
Hydrogen	H	1	1
Carbon	C	6	12
Nitrogen	N	7	14
Oxygen	O	8	16
Sodium	Na	11	23
Magnesium	Mg	12	24
Phosphorus	P	15	31
Sulfur	S	16	32
Chlorine	Cl	17	35
Potassium	K	19	39
Calcium	Ca	20	40
Iron	Fe	26	56
Iodine	I	53	127

*Hydrogen, carbon, nitrogen, and oxygen are the most abundant chemical elements in living organisms.

*** 6 make up 98% of all living mass**

Table 2.1

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C. Electronic Configurations

- Electrons are arranged in electron shells corresponding to different energy levels.

- ***Octet Rule:*** past H and He, all other atoms are most stable with an outer electron shell filled with 8 Electrons!!
  - **Closer to 8 = tend to grab electrons!**
    - **HIGH** *electronegativity/ electron-affinity* *…. Tend to become….*
  - **Further from 8 = tend to give-up electrons!**
    - **LOW** *electronegativity/ electron-affinity* *…. Tend to become….*

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Electronic Configurations

TABLE 2.2 **Electronic Configurations for the Atoms of Some Elements Found in Living Organisms**

Element	First Electron Shell	Second Electron Shell	Third Electron Shell	Diagram	Number of Valence (Outermost) Shell Electrons	Number of Unfilled Spaces	Maximum Number of Bonds Formed
Hydrogen	1	—	—		1	1	1
Carbon	2	4	—		4	4	4
Nitrogen	2	5	—		5	3	3
Oxygen	2	6	—		6	2	2

Key: electron, unfilled space, atomic nucleus

Table 2.2.1

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Electronic Configurations

TABLE 2.2 **Electronic Configurations for the Atoms of Some Elements Found in Living Organisms** (continued)

Element	First Electron Shell	Second Electron Shell	Third Electron Shell	Diagram	Number of Valence (Outermost) Shell Electrons	Number of Unfilled Spaces	Maximum Number of Bonds Formed
Magnesium	2	8	2		2	6	2
Phosphorus	2	8	5		5	3	5
Sulfur	2	8	6		6	2	2

Key: electron, unfilled space, atomic nucleus

Table 2.2.2

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