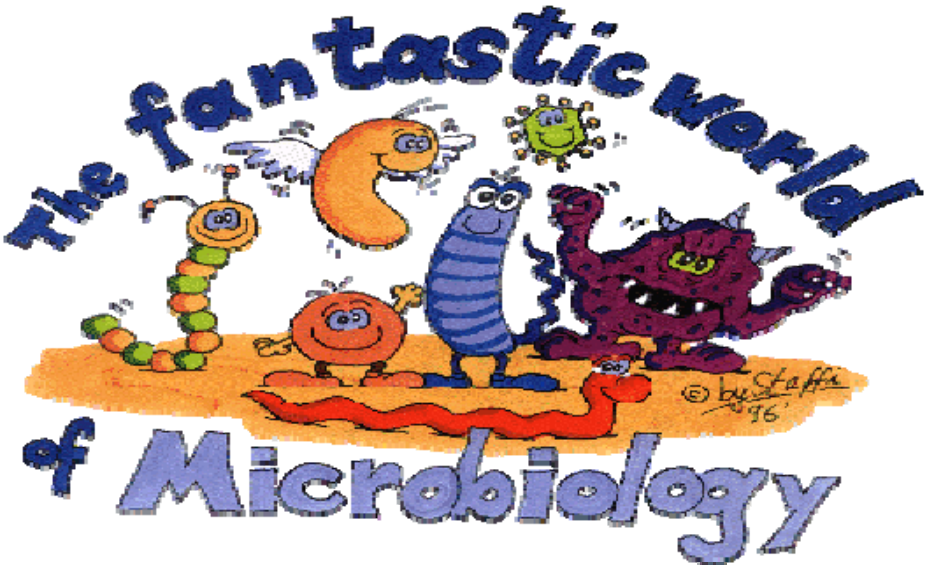
Introduction to Nursing Microbiology

Microbiology…What is it?

Microscopic?



Microorganisms…What are they?

Microbes…Where are they?

Bacteria

Disease: infections, diet, genetics, and aging…

Infection: pathogenic microbe penetrate, tissue, multiply, damage/disrupt tissues and organs.

Infectious Disease:

Microbes and their products

Contact…Host between

Human and bacteria

What role does microorganisms play in our everyday life?

Nurses…

A Historical Perspective:

- An old human society.
- No knowledge of disease or any of the medical knowledge of today, it was the ***very act of caring for an individual that was the essence of their practice.***
- As civilization progressed new ideas and socialization began to have an impact on nursing.

Slaves:

As civilization progressed through thousands of years new ideas and social constructs began to have an impact on nursing.

- ***While some nurses were still skilled women with authority, either in the family or employed by the wealthy, most had become servants***.

It was not uncommon in ancient ***Persia or Babylon for a slave to be forced into nursing***. If the ***slave nurse's master died, she could be burned alive so to provide care in the afterlife.***

Physician:

- A male who had specialized skills different from a nurse.

Nurse:

Most (all) societies were male dominated, nurses were **subservient** to "doctors".

- The nurse's role had regressed to that of an **assistant caregiver.**

Religion:

- Under the umbrella of religion because of perceived causes of illnesses…

Disease:

- Invasive demon, sin, or punishment from the gods.
- Cures: scaring a demon out, drilling holes in head to provide exit points for bad influences, prayer, rituals, and even human sacrifices.

Middle Ages and Renaissance

- Medicine…scientific endeavor and moved away from mysticism.
- Nursing had ***moved from the slave quarters of wealthy families to the nunnery as well as few schools.***

1600s:

- The spiritual leadership of St. Vincent de Paul had led to an enrichment of nursing.
- He recognized that nursing could be ***a social force, helping not only the ill but also the poor, hungry, sad, and lonely.***
- He saw the need for, and created, a program for nursing education, helping to start the *Dames de Charité.* This was an early nursing group which later gave rise to the secular *Sisters of Charity* in 1633. Both were led by women and serve as the earliest examples of "nursing schools".
- Women of faith would put their hearts and souls into caring for the ill to answer a higher power.
- **It was here that the usage of "sister" becomes synonymous with nurse.**

Florence Nightingale:

- Born in 1820 to a wealthy British family, Florence was given social and educational opportunities not afforded to most Victorian era women.

- She combined her intelligence and sense of humanity and ***began nursing in 1845.***

- Always looking for new techniques or insights, ***Nightingale's career took off in 1851*** when she received ***four months' training in Germany as a deaconess of Kaiserswerth Hospital***.

- In England, she was becoming well known for her ***skills as well as her push for healthcare reform.***

- ***By 1853, she had a post as superintendent*** at the ***Institute for the Care of Sick Gentlewomen in London.***

- ***In 1854, she and 40 nurses picked by her went to assist the military hospitals in Scrutari during the Crimean war.***

- This was in response to public outcry at the high mortality rates being reported from frontline reporters, contrary to official military releases. ***Within two months of her arrival mortality rates in the barracks dropped from 42% to 2%.***

- This was mostly due to her practice of ***rigorous sanitation and infection control***. When she returned to England at war's end she was the second most popular woman next to Queen Victoria. Florence would use her social influence to change the face of nursing.

- Known for introducing cleanliness and other antiseptic techniques into nursing.

The Link as a nurse…sanitation and infection control…How can you treat what you do not know

Chapter 1 - Main Themes of Microbiology

Microbiology:

- Microbiology is the specialized science that deals with the study of organisms that require magnification to be observed (>.1mm) – less than 2 micrometers (um).one millionth of a meter.

- Employs techniques:
  - **sterilization** and the use of **culture media** – necessary for isolation and growth of microorganisms.

What are microorganisms?

- Generally smaller than the human eye can detect and belong to each of the five kingdoms: **Monera, Protista, Fungi,** Plantae, and Animalia.

- The subjects of microbiology include bacteria, algae, fungi, protozoa, and helminths all of which are cells and **viruses which are not cells.**

- The majority of microbes exist as single cells or clusters of single cells; however some are multi-cellular existing as filamentous multi cells.

Microorganisms or Microbes:

- Oldest organisms evolved over 3.5 – 3.8 billion years ago.

Microorganisms are ubiquitous:

- *EveryWHERE*
- *From deep in the earth's crust-- to the polar ice caps and oceans -- to the bodies of plants and animals.*
- *Mouth, colon, ears, teeth, arms, hands, feet, feces, skin, vagina, external eye, upper respiratory tract, just to name a few places…*

Microbiologist study:

- ***Cell structure and function, physiology, characteristics that may cause disease***
- ***Genetics, Immunology***
- ***Biochemistry***
- ***Epidemiology***
- ***Ecology***
- ***Food microbiology, dairy microbiology, and aquatic microbiology***
- ***Agricultural microbiology and biotechnology***
- ***Genetic engineering and recombinant DNA technology***

Two Basic Types of Microorganisms*: Prokaryotic and Eukaryotic*

- Pro (before) caryos (nucleus)
- Eu (true) caryos (nucleus)

Prokaryotes include the bacteria and cyanobacteria which were formerly classified as blue-green algae.

- They possess a simple make-up that **does not contain sub-cellular organelles**.
- The **typical size of a prokaryote is about 1um diameter**.
- Archaebacteria and Eubacteria

Eukaryotic organism possess a complex cellular structure.

- **Contain membrane-bound organelles** such as mitochondria, lysosomes, endoplasmic reticulum and golgi bodies.

Microbes do what they do independent of human values:

- They are "good" or "bad" depending upon how we choose to see them.
- ***Over 90%*** of all known species of microorganisms are either ***neutral or beneficial*** to human beings.
- **Less than 10% are harmful in some way.**
- One important goal of microbiology is to better understand the activities of these organisms so that we can minimize what we consider to be their harmful effects and maximize their beneficial effects.

Some questions we will address in this course:

(1) What are microorganisms?

(2) Where are they found?

(3) How do we identify them?

(4) What activities do they have?

(5) How do they affect us?

(6) How can we control them?

HISTORY OF MICROBIOLOGY

- Microscopy
- Scientific Method
- Development of Medical Microbiology
- Modern Microbiological Techniques

LEEUWENHOEK (1655-1676) – Microscope

The existence of microorganisms and their relationship to disease was suspected, long before they could actually be seen, but real **physical evidence** was not available until the invention of the microscope.

In 1673 Antony van Leeuwenhoek (Dutch linen merchant and self-made microbiologist)

- *discovered microorganisms, which he called "animalcules".*
- *Father of bacteriology and protozoology.*
- Leeuwenhoek's microscopes were able to achieve **50-300X magnification**, which enabled him to visualize a variety of bacteria and protozoa.
- **He communicated his findings to the Royal Society of London, but kept his techniques for grinding lenses and making observations a secret.** Consequently his contemporaries had a very difficult time repeating his results.

Spontaneous Generation – shaped the science of microbiology:

Spontaneous Generation refers to the ancient belief ***that living organisms could arise spontaneously from nonliving matter.***

The Greek philosopher Aristotle believed insects and other small animals had to arise from spontaneous generation because he was unable to observe organs (including reproductive organs).

Abiogenesis and Biogenesis:

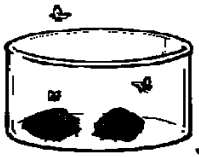
- Abiogenesis: Spontaneous generation
- Biogenesis: Living things only arise from other living things.

This belief prevailed until 1665, when ***Francesco Redi***, an ***Italian physician,*** attempted to address the question of ***Spontaneous Generation*** experimentally.

He made careful observations of fly eggs and maggots by placing decaying meat in a jar. Concluded:

- spontaneous generation was not occurring.

The Decaying Meat Experiment

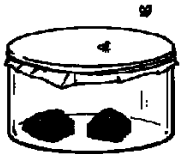


Jar-1

- Jar left open, maggots developed, flies were observed laying eggs on the meat in the open jar.

Jar-2

- Jar covered with fine gauze, maggots appeared on the fine gauze, flies were observed laying eggs on the gauze. These eggs produced maggots.



Jar 3

- Jar covered and sealed, no maggots developed.
- ***MEAT*** did not spontaneously generate maggots as previously believed.

- THEREFORE DISPROVING THE SPONTANEOUS GENERATION!

In 1843, an American physician, Oliver Wendall Holmes published a paper on Puerpeal (PURE-PER-AL) sepsis which afflicted mothers during childbirth.

- Holmes reported that it was much safer to deliver a baby at home than in a hospital... where physician-handling contribute to the disease.

1848, Ignaz Semmelweiss:

- A Hungarian physician on the obstreric ward of a teaching hospital in Vienna.

- Ridiculed for insisting that physicians wash their hands before working with pregnant women.

- The residents frequently handled cadavers in the morgue before coming to the maternity ward and he hypothesized that these cadaver particles were carried from their autopsy studies into the delivery room and these particles resulted in puerperal fever/ infections.

- Semmelweiss conducted experiments that hand washing would reduce the incidence of disease from 30% to less than 3%.

- Physicians still refused to wash their hands and admit that they were unclean.

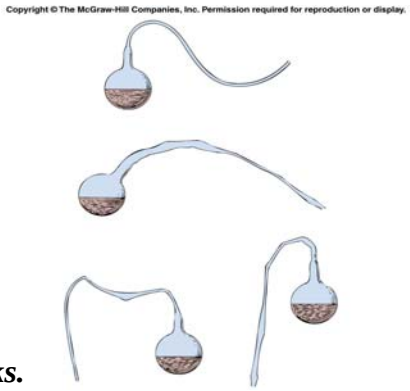
Swan Neck Flasks Experiment

In 1861, Louis Pasteur devised an experiment that would settle the controversy.

- Pasteur first filtered air through cotton and found a particulate matter that resembled plant spores.

- If the cotton was placed into a **"sterile"** medium, growth occurred.

He then demonstrated that ***Swan-necked Flasks*** containing a nutrient broth, previously heated would remain sterile, even with open necks.



- He placed nutrients solutions in flasks
- Heated their necks in a flame
- Drew them out into a variety of curves, while keeping the ends of the necks open to the atmosphere.
- Boiled the solution for a few minutes and allowed them to cool.
- ***No growth took place***

Pasteur concluded that the contaminating particles in the air were trapped on the walls (necks) of the curved irregular flasks.

- **If the necks were broken, growth occurred**.

1. **Pasteur, Louis (1860s)**
    a. **Anti-spontaneous generation experiments:**
        i. *Pasteur* definitively demonstrated that microorganisms are present in air but not created by air.
        ii. This was critical for refutation of the concept of spontaneous generation and the for development of germ theory of disease.
    b. **No contamination when air is withheld:**
        i. Sterilized broth by boiling.
        ii. Exposure of sterilized broth to air resulted in contamination of broth by microorganisms (i.e., the broth became turbid).
        iii. Protection from *air*, by sealing, prevented contamination.
    c. **Contamination due to air-borne particles:**
        i. Curved neck flasks allowed contact with air but inhibited movement of non-gaseous particles.
        ii. Contamination was prevented (microdes stuck to neck of flask, did not reach broth)---air alone was not sufficient to induce contamination, must be something *carried* by air.

d. Vaccine discoverer:

i. *Pasteur* played key roles in the discovery and development of vaccines such as the rabies vaccine.

ii. "In gratitude for Pasteur's development of vaccines, people from around the world contributed to the construction of the Pasteur Institute in Paris, France." (p. 10, Prescott *et al.*, 1996)

e. Microorganisms responsible for fermentation:

i. Fermentations are such things as the formation of alcohol or acetic acid in grape juice to form wine or vinegar.

ii. Demonstrated that fermentations occur as a consequence of the actions of http://www.mansfield.ohio-*state.edu/~sabedon/biol2007.htm#kochmicroorganisms.*

Scientific Method

- Approach taken by scientific to explain a certain natural phenomenon.
- The development of the experimental system that answered questions objectively.
- During the 1600s

The Scientific Method

- **Hypothesis** – formulate a hypothesis
  -- a tentative explanation to account for what has been observed.
- **Predictions**
- **Testing** --experimentation, analysis, and testing
- **Conclusion**
- **Theory**
  -- a collection of statements, prepositions, or concepts that explains or accounts for natural events.

Joseph Lister:

Impressed with Pasteur's studies on the involvement of microorganisms in fermentation, Holmes, and Semmelweiss' research, in ***1867, Joseph Lister, an English surgeon.***

- Considered the father of antiseptic surgery.
- The first to introduce to **aseptic techniques – reducing microbes in a medical setting and preventing wound infections.**
- Developed a system of **antiseptic surgery designed to prevent microorganisms from entering the wounds.**
- Demonstrated that boiling instruments (heat sterilized) and applying carbolic acid to dressings that covered wounds dramatically reduce the incidence of disease following surgery.
- Phenol was used on surgical dressing and at time sprayed over the surgical area.
- This approach transformed surgery.

In 1877, English physicist, ***John Tyndall,*** demonstrated that dust did carry germs and that if dust was absent, broth remained sterile even if directly exposed to air.

- **Providing the final blow to spontaneous generation.**
- **Began the importance of heat resistant spores and sterility—initial evidence of microbes in dirt/air – highly heat resistant.**

KOCH: an associate of Pasteur…

- ***Robert Koch demonstrated the first direct role of a bacterium in disease.***

In ***1872-1875,*** Koch began his work on the disease ***called anthrax,*** which is a devastating disease that affects cattle, often wiping out entire herds.

Anthrax is common disease but can also be transmitted to humans.

- In most common form of the disease, *B. anthracis* enters the body through skin abrasions.
- Gets into the bloodstream.
- Causes septicemia and death.
- Koch established that a specific bacterium***, Bacillus anthracis*** was the cause of the disease in mammals.
- Clearly linked a microscopic organism with a specific disease.

In 1880s – he identified the bacterium that causes tuberculosis - ***Mycobacterium tuberculosis*** and ***developed a method of staining the organism and disproved that it was inherited.***

He also guided the research that led to the isolation of ***Vibrio cholera.***

The Germ Theory of Disease:

The germ theory of disease is the single most important contribution by the science of microbiology to the general welfare of the world's people, perhaps the single most important contribution of any modern scientific discipline. It also is the single most important contribution to the practice of modern medicine, essentially defining the term with the invention of antimicrobial chemotherapeutics. To gain a fuller appreciation of how far we have come, in this lecture we will briefly consider the history of the science of microbiology and the concurrent development of the germ theory of disease.

1. **Germ theory of disease**
    a. **Microorganisms cause disease:**
        i. The theory that microorganisms may be the cause of some or all disease.
        ii. The reason medical personnel have to take courses in microbiology.
    b. **Foundation of modern medicine:**
        i. *Germ theory of disease* is the single most important contribution to medical science and practice, ever.

http://www.mansfield.ohio-state.edu/~sabedon/biol2007.htm

Introduction of the development of Medical Microbiology.

KOCH'S POSTULATES

In ***1881 Koch proposed 4 postulates*** that could be used to prove whether or not an infectious agent is the cause of a disease. It is the scientific method of establishing the Germ Theory of Disease.

I. The causative agent must be present in every case of the disease and absent in healthy animals.

II. The agent of disease can be isolated from the diseased animal and can be grown in pure culture (A population of one organism).

III. The disease can be reproduced by inoculating a portion of the pure culture into healthy animals.

IV. The agent of disease can be re-isolated from the infected animal.

- Koch's proof that *Bacillus anthracis* caused anthrax was independently confirmed by Pasteur and his coworkers. They discovered that after burial of dead animals, anthrax spores survived and were brought to the surface by earthworms. Healthy animals then ingested the spores and became ill.

- ***Koch also developed media that was suitable for growing bacteria isolated from the human body, many of which are still in use today.***

- ***Koch* also invented nutrient broth and nutrient agar.**

- ***Koch developed and reported the simple stain technique in 1877***

Christian Gram – Danish scientist:

- *1884 – Gram stain (still the most widely used staining techniques)*

Julius Richard Petri:

- An associate of Koch developed the ***petri dish***, which allowed ***isolation of pure cultures.***

- The invention of the dish is most commonly attributed to Julius Richard Petri (1852-1921).

- In the latter part of the 19th century, Petri worked as a laboratory assistant for the renowned German scientist Robert Koch. Previous to the men's work, researchers cultured bacteria in broth. In 1881, Koch decided to try growing bacteria on solid media so he could more easily separate (and, more importantly, clearly observe and identify) different strains of bacteria in a single culture. He initially used gelatin spread on a flat piece of glass. However, in 1887 his assistant Petri made the advance of using a flat, coverable dish which they soon developed into the object we are familiar with today.

Referenced from http://www.everything2.com/index.pl?node=Petri%20dish

1. **Iwanowski, Dmitri (1890s)**
    a. *Dmitri Iwanowski* discovered the first virus, tobacco mozaic virus.

2. **Fleming, Alexander (1920s)**
    a. **Penicillin/first antibiotic:**
        1. *Fleming* discovered that a mold accidentally growing on one of his petri dishes had anti-bacterial activity.
        2. The mold was producing penicillin.
        3. This was the first antibiotic discovered.
    b. Because of problems with mass production, the use of *penicillin* did not become widespread until the 1940s (p. 11, Tortora et al., 1995).

http://www.mansfield.ohio-state.edu/~sabedon/biol2007.htm

Humans and the Microbial World

Vital Activities of Microorganisms

- Nitrogen fixation to help replenish the oxygen needed
- Nitrogen is essential part for molecules such as nucleic acids and proteins
- Nitrogen common gas in the atmosphere

Applications of Microbiology

- **Biotechnology:** application of biology to solve practical problems and products economically
- **Food production:** beer, bread making, milk products
- **Bioremediation:** use of living organism to degrade environmental pollutants
  Examples of pollutants in the environments: PCB's, DDT and trichloroethylene

Genetic Engineering:

- Introducing genes from one organism into another organism and conferring properties on that organism.

Genomics:

- Sequencing the DNA of bacteria to reveal all of its genetic information.

Medical Microbiology

- 750 million cases of infectious diseases of all types in US /year
- Every year 200,000 deaths
- Tens of billions of dollars

Emerging Diseases last several decades:

- Legionnaire's disease
- Toxic Shock Syndrome
- Lyme disease
- AIDS
- West Niles Virus

These diseases are not new, but there has been an increase world wide, therefore bringing them back into the Lime Light!!

- They have been isolated, characterized and identified as the causative agent of disease creating a need to develop methods to prevent them.

Factors that account for the rise of Emerging Diseases:

(1). Changing lifestyles bring new opportunities for infectious agents to cause disease.

- Vaginal tampons used by women – environment for the organism causing toxic shock syndrome, can grow and produce a toxin.
- Developments: suburbs expanding into rural areas – closer contact between humans into closer contact with animals, exposing people to viruses and infectious organisms that was once removed from the environment.

- Hantavirus: infects rodents w/o causing disease, infected animals sheds virus in urine, feces, and a saliva, thereby causing the virus to be inhaled as an aerosol by humans.

(2). Infectious agents changed abruptly and gain the ability to infect new hosts
- HIV – Human Immunodeficiency Virus, the cause of AIDs (Acquired immunodeficiency syndrome), is thought to have originated from a virus that once infected a monkey.
- Pathogenic and Nonpathogenic strains of bacteria only differ in some contain larger pieces of DNA that can confer the ability to cause disease.

Resurgence of Old Diseases:
- Increase and appearance of old disease is more deadly because the causative agents resist the antibiotics once used for treatment.

Factors that account for the resurgence of Old Diseases:

(1). Traveling Abroad:
- Malaria, cholera, plague, and yellow fever

(2). Parents relaxed about childhood vaccination
- The unvaccinated child is highly susceptible, therefore increasing the number of infected children.
- Measles, polio, mumps, whooping cough and diphtheria

(3). Elderly people in the population who have weakened immune systems and are susceptible to a wide variety of diseases that younger people readily resist.

Chronic Disease caused by Bacteria:
Peptic ulcers:
- Caused by *Helicobacter pylori* and is treatable by antibiotics

Why is it important to study microorganisms?

Abundance	**Negative impact on humans**	**Positive impact on Humans**
	Disease	Biodegradation
	Food Spoilage	Food Production
	Biodegradation	Food Source
		Element Recycling
		Production of Industrial and Medical Products
		Genetically-engineered Microorganisms (GEMs)

Abundance

- They have the same fundamental metabolic and genetic properties as higher life forms.
- Microbes are ***ubiquitous*** and prolific in the world around us.
- They ***inhabit the air we breath, the food and water that we eat and drink, the ground that we walk on, and our bodies!***
- The surface ***of our skin contains over 2 million (2 X 10^6) microbes per square inch***.
- A ***single gram of fecal material, contains over 100 billion (1 X 10^{11}) bacteria***
- A human being consists of approx. 100 trillion (1 X 10^{14}) cells. Of that number only 10% are mammalian in origin. ***The remaining 90% are microbes and together weigh about one-quarter of a pound.***
- ***Microbes are most common in soils***, especially where there is a potential source of food.
- On average, ***one gram of soil harbors more than 10 million microbes (1 X 10^7)***
- ***And when we count the number of microorganisms in the air that we breath, we find that it contains 50-100 microbes per cubic foot***
- ***Microbes have developed some extraordinary survival adaptations that enable them to exist in a wide range of environments.***
- ***Many microorganisms form cysts or spores, when the food or water source disappears.***
- ***The organisms can exist in this dormant state for years until the environment becomes more favorable***
- ***As the nutrient source becomes more abundant, the spores can revive and develop into viable organisms.***
- ***Archaeologists found, and successfully revived spores that that were dormant for thousands of years in sealed amphoras on greek shipwrecks.***

In spite of their abundance, microorganisms are most noted for their **negative impact** on the human lifestyle.

- In fact when microbes are most commonly associated with their ability to cause disease.

Pathogens:

- Disease causing microorganisms.
- 2,000 different microbes that cause various types of disease.
    - 10 billion new infections across world every year.

- Infectious diseases are among the most common causes of death

Disease is not the only way in which microbes have a **negative** impact on humans. They can also profoundly affect our lives through ***food spoilage and Biodegradation.***

We have all, at one time or another encountered:
(a) Bread mold
(b) Soft rot of fruits and vegetables
(c) Soured milk
(d) Canned food spoilage (botulism)

Decomposition:

- ***Breakdown of dead matter and wastes into simple compound. That can be directed back into natural main forces.***

Examples of Biodegradation

(a) Wood rot, rubber, paint, metal, cloth, etc.
There is not a single compound made by man which cannot be destroyed by a microorganism.

Believe it or not, microbes can also have a ***Positive Impact*** on humans
Reference: National Geographic, August 1993, pp. 36-61.

Microbe mediated Biodegradation can be used to clean-up the environment
MEOR

- Many fungi and genetically engineered bacteria can be used to affect a gradual breakdown of most toxic wastes, oil spills, pesticides, detergents, and other environmental pollutants.

- Microbes are a critical component of modern sewage treatment processes.

- If it weren't for microorganisms we would all be rotting in our own waste products

Food Production

Microbes can also be utilized in the production of food:

- ***The fermentative metabolism of the various fungi used to make Alcoholic beverages*** (beer, wine, and liquors)

- Microbes are also responsible for dairy products such as ***cheese, butter, and yogurt***

- ***Yeast is used as a leavening agent for making bread***

- ***And microbial fermentation reactions are also used to produce Vinegar (acetic acid)***

Microbes are critical to ***element recycling in the environment***:

- the ***carbon, nitrogen, and sulfur cycles.***

Microorganisms are used in the production of ***numerous industrial and medical products***

- Organic solvents (acetone, toluene)
- Vitamins
- Antibiotics
- Vaccines
- Even plastics

Genetically-engineered microorganisms can be used as biological factories to produce a wide array of biomedical reagents and as a source for useful genes (i.e. for gene therapy)

The Microbial World

The Bacteria:

- A lot of diversity within this group of organisms
- Single-celled prokaryotes
- Specific shapes/morphology:
  - Coccus: round or spherical
  - Bacillus: rod shaped
  - Spiral

- Most have rigid cell walls: accountable for the shape of the organism.
  Peptidoglycan:
  - contained within the cell wall of the bacteria identifying whether a bacteria is ***gram positive (+) or gram negative (-)***
  - Not found in the Archea or the Eucarya

- Multiply by **binary fission**: one cell divides into two daughter cells
- Move by flagella

Archaea:

- Have the same shape, size and appearance as the Bacteria
- Multiply by binary fission
- Moves by flagella
- Have rigid cell walls
- **Cell wall composition differs from that of the Bacteria**
- **They do not have peptiodoglycan as part of their cell walls.**

- **They have an ability to grow in extreme environments in which most other organisms can not.**
    - Found in very high salt concentrations 10x greater than the seawater.
    - Very high temperatures above 105° C

Eucarya:

- Include all members except that of prokaryotes
- Consist of the eukaryotic cells
- Contain single-celled and multi-cellular members
- Include the following:
    - Algae:
        - contain a green pigment chlorophyll which absorb light, which algae use a source of energy.
        - Found near surface of either salt or fresh water
        - Cells walls are rigid, but do not contain peptidgylcan
        - Moves by flagella
    - Fungi:
        - Single celled and multi-cellular
        - Include molds and mushrooms
        - Gain their energy from organic materials
        - Live mostly on land
    - Protozoa:
        - Single celled
        - Live in both aquatic and terrestrial environments
        - Larger than prokaryotes
        - Do not have a rigid cell wall
        - Require organic cmpds. As a source of food

Nomenclature:

- Binomial System Nomenclature – a two word naming system
- The first word is the **genus** and is always capitalized
- Second word is the **species** name and is not capitalized
- Both words are italicized
- Example: *Escherichia coli* *E.coli*
- Many bacteria are named after the person who first isolated and described it,
- Theodor Escherich
- Species name comes from the location where the organism was found, the colon.

Viruses, Viroids, and Prions

- All three are obligate intracellular agents

Viruses

- They are considered neither prokaryotic nor eukaryotic.
- ***They are not even considered CELLS.***

- They are informational parasites, a piece of nucleic acid surrounded by a protein coat
- They are only considered to be “alive” when they are inside another living cell and can only multiply inside living host cells.
- They are described in terms of their *transmissible state as a virus particle*.
- Viruses exit for every group of organism known (including bacteria) and they are typically less than 0.2 um in diameter.
- Termed obligate intracellular parasites

Viroids

- Simpler and smaller than viruses
- Composed of a single, short piece of nucleic acid, specifically ribonucleic acid (RNA) with no protein coat.
- Reproduce only inside the host cells.
- Causes plant disease, scientist speculate they may cause diseases in human.

Prions

- Only protein without the nucleic acid.
- Responsible for six neurodegenerative diseases in humans and animals.
- Always fatal.