Module 1

Chapter 1 – The microbial world and you

Microbes in our lives
Overall theme of this course is to discuss microbes and how they are involved in the lives of humans. Microbes make the biggest news when they are causing harm

• Microbiology – The study of ________________
• Microbes are organisms ______________________________ to be seen with the ________________
  o aka, Microorganisms, germs, bugs
  o Includes bacteria, fungus, protists, algae, viruses
  o Huge diversity in ______________________________ – only common theme is that ________________

• Microbes are everywhere
  o Most famous, or infamous, microbes ______________________
    ▪ TB, AIDS, food spoilage
  o ______________________ are microbes that ______________________
  o Only ______________________ of microbes are ______________________
• Most microbes are ______________
  o Directly beneficial
    ▪ ______________________ (bread, yogurt, beer), make ______________________ in intestine
  o Indirectly beneficial
    ▪ ______________________ organic matter in soil, clean up sewage, part of food chain

Naming and classifying microorganisms
• Nomenclature → system of naming for organisms
• Carolus Linnaeus established the system of scientific nomenclature
• Based on ______________________ → language of scholars
• ______________________ names → ______________________ system
• The ______________________ and ______________________________, which are italicized or underlined
• The genus is ______________________, species is in ______________________
• *Staphylococcus aureus, Escherichia coli*
• After the first use, scientific names may be abbreviated with the ______________________ and the ______________________:
  o *Escherichia coli* and *Staphylococcus aureus* are found in the human body
  o *E. coli* is found in the large intestine, and *S. aureus* is on skin

Types of Microorganisms
• Diverse variety of microbes
• Microbes are classified into groups that share ______________________
• Microbes ___________ groups can also be diverse
• Helps ___________ a very diverse group of organisms

○ Bacteria (bacterium)
  ○ Single celled
  ○ ________________ – no ________________
  ○ ________________ cell walls
  ○ Diverse metabolism
    ▪ Organic chemicals, inorganic chemicals, or light as food

○ Archaea
  ○ ___________ celled
  ○ ________________
  ○ ________________ in cell wall
  ○ Archaea of interest:
    ▪ Extreme ________________ – produce methane
    ▪ Extreme ________________ – live in ________________ environments
    ▪ Extreme ________________ – live in ________________ environments

○ Fungus (pl, fungi)
  ○ ________________ – contain ________________
  ○ ________________ cell walls
  ○ Use ________________ for energy
  ○ ___________ are ____________cellular
    ▪ Mushrooms, molds
  ○ Some are single celled
    ▪ ________________

○ Protozoan (pl, protozoa)
  ○ ________________ celled, ________________ cells
  ○ Absorb or ingest organic chemicals
  ○ May be motile via pseudopods, cilia, or flagella

○ Alga (pl, algae)
  ○ ________________ cell walls
  ○ Use ________________ for ________________
  ○ “______________ producers”
    ▪ Produce ________________ and ________________ that other organisms consume

○ Viruses
  ○ Extremely ________________ particles - ________________
  ○ Consist of ________________ core
  ○ Core is surrounded by a ________________ coat
  ○ Coat may be enclosed in a ________________
  ○ Are replicated only when they are in a living host cell
    ▪ Obligate ________________ – ________________
• Multicellular animal parasites
  o _________________________
  o Multicellular ___________________________
  o Parasitic __________________ and __________________ are called helminths
  o Microscopic stages in life cycles

**Modern Developments in Microbiology**

- **Bacteriology**
  o Study of __________
- **Mycology**
  o Study of __________
- **Parasitology**
  o Study of __________ and __________ worms
- **Virology**
  o Study of __________
- **Immunology**
  o Study of _______________________
- **Microbial genetics**: the study of _______________________
- **Molecular biology**: the study of how _______ directs ___________________
- **Genomics**: the study of an organism's ____________; has provided new tools for classifying microorganisms
- **Recombinant DNA**: DNA made from two _______________________
  o In the 1960s, Paul Berg inserted animal DNA into bacterial DNA, and the _______________________
  o _____________, the use of microbes to ________________________, is centuries old
- **Recombinant DNA technology**, a new technique for biotechnology, enables bacteria and fungi to produce a variety of proteins, including vaccines and enzymes
  o _________________________ in human cells can be replaced in
  o Recombinant DNA technology can be used to _____________ from pests or make them resistant to harsh environments

**Microbial Ecology**

- **Bacteria** _________ carbon, nutrients, sulfur, and phosphorus that can be used by _______________________

**Bioremediation**

- **Use of ____________ to ________________ chemical ____________ in environment**
  o Bacteria degrade organic matter in sewage
  o Bacteria degrade or detoxify pollutants such as oil and mercury
Biological Insecticides
• Microbes that are __________________________ are alternatives to chemical __________________________ in preventing insect damage to agricultural crops and disease transmission
• __________________________ infections are fatal in many insects but __________________________ to __________________________, including humans, and to plants

Microbes and Human Disease
• Microbes normally __________________________ the human body are called __________________________
• Normal microbiota __________________________ of pathogens
• Normal microbiota produce __________________________, such as folic acid and vitamin K
• Only a small proportion of microbes are __________________________
  o Many more microbes __________________________
• When a pathogen __________________________ the host’s resistance, __________________________
• __________________________ (EIDs): __________________________ diseases and diseases __________________________
  o Avian Flu
  o West Nile
  o MRSA
  o AIDS
  o Ebola

Chapter 2 – Chemical Principles

• **Chemistry** is the study of __________________________ between atoms and molecules
• The __________________________ of microorganisms involve complex __________________________
• Nutrients are broken down by microbes to __________________________ and to make __________________________

The Structure of Atoms
• Atoms – __________________________ of matter
• Consist of:
  o __________________________
    • __________________________
    o __________________________: __________________________ charge, have no discernable __________________________
• Molecules – combination of __________________________ atoms
  o Sometimes called __________________________
• Ion – __________________________ atom
  o Can be __________________________ or __________________________ charged

Chemical bonds
• __________________________ are held together by __________________________ to form __________________________
Three kinds of chemical bonds

• Ionic bonds
  o Attraction between __________________________
  o __________________________ are __________________________ to each other
    ▪ “Opposites __________________
  o Ions held together by __________________________, __________________________ interaction
    ▪ Form an __________________________

• Covalent bonds
  o Bonds formed when __________________________
  o __________________________ interaction
  o Bonds can form between 2 ________ atoms, or 2 ________ atoms
  o Strongest chemical bond

• Hydrogen bonds
  o Form between:
    ▪ A hydrogen atom covalently bonded to an ________ or ________ atom and;
    ▪ Another ________ or ________ atom
  o Order of bond strength: __________________________ > __________________________ > __________________________
  o Stronger ionic bonds not biologically relevant
    o Only ________ ionic bonds are biologically important
  o Covalent bonds require __________________________ to form, break
    o Energy can be __________________________ when covalent bonds
      __________________________, __________________________ when they are
      __________________________
  o __________________________ bonds are biologically important
    o ________ bond, can be __________________________ and
    o Can __________________________ 2 molecules, or parts of the ________ molecule
    o Maintains __________________________ structure of many molecules

Important biological molecules

• Organic compounds always __________________________
• Inorganic compounds typically __________________________

Inorganic molecules

• ________ and structurally ________
• Typically lack ________ atoms
• Water
  o Most important ________ molecule for supporting life
    ▪ Hydrogen bonds between __________________________ make it a good
      ________.
  o __________________________ – a liquid with __________________________
  o __________________________ – the __________________________
• _______________ – the dissolving _______________
• The ability of water to form _______________ makes it an excellent solvent
  o _______________ many molecules
• Dissolving molecules helps with _______________
  o Atoms and molecules in solution can _______________

**Organic compounds**
• _______________ and structurally _______________
• Contain _______________ atoms
  o Carbon can bond with ____ atoms, including ______
  o Can form chains, branches, rings
• Organic molecules can combine to form large _______________ (“big molecules”)  
  o _______________ – _______________ formed by covalent bonding of  
    many repeating _______________  
  o _______________ – small molecules that make up _______________
• Polymers are formed from monomers via _______________
  o _______________ is removed during the reaction (molecule is dehydrated)
• Polymers are broken down into monomers via _______________
  o Water is added to break (or _______________) the polymer

**Carbohydrates**
• Group of organic compounds that include _______________ and _______________
• Important functions:
  o _______________ (cell walls, DNA)  
  o _______________; fuel and storage
• Made up of C, H, O
• _______________ are building blocks (_______________) of carbohydrates
• Monosaccharides _______________ sugar
  o Usually _______________ in water
• Grouped by _______________ in ring
  o Triose (3 C), Tetrose (4 C), Heptose (7 C)
• Disaccharides
  o Molecule of ____ monosaccharides
  o Formed from two monosaccharides by?  
  o Broken into 2 monosaccharides by?
• Polysaccharides
  o Consist of _______________ monosaccharides
    ▪ Often number in the 100s
  o Some important polysaccharides
    ▪ Glycogen – energy reserve in _______________
    ▪ Cellulose – main component of ______ and _______ cell walls
    ▪ Starch – energy reserve in ______, eaten as food by animals
Lipids
- Diverse group with one common property:
  - Hydro______________ - ____________________________
- Primary functions:
  -
  -
- Simple lipids
  - __________ or ________________
  - Contain:
    - Glycerol – 3 carbon ________________
    - 3 Fatty acids – long chain of ___________ and __________
  - Type of _______________ determine __________ of triglyceride
  - Saturated fatty acids have the ________ number of _______ (2) per carbon
    - Saturated fatty acids are relatively _______, can pack closer together
    - Usually __________ at room temperature
    - __________ fats (butter) tend to be high in saturated fatty acids
  - Unsaturated fatty acids have ________________ double bonds between 2 carbons
    - Creates __________, or __________, in chains
    - Keeps chains __________
    - Usually __________ at room temperature
- Complex lipids
  - Contain ______________ attached to glycerol in addition to the fatty acids
    - Phosphorous, oxygen, nitrogen, sulfur
  - Phospholipids made up of glycerol, ___ fatty acids, a ______________ group
    - Essential lipids that build ___________________________
    - Phospholipids have hydrophobic and ________________ (water loving) regions that allows for formation of cell membranes
- Steroids
  - ________________ from other lipids
    - Interconnected carbon ________________
  - A steroid, ________________, important part of some ________________

Proteins
- Most ________________ organic molecule in a cell
- Perform ________________ functions; cellular tools
  - Enzymes – proteins that speed up biochemical reactions
  - Transport – transport chemicals into and out of cells
  - Toxins – harm living organisms
  - Structure – in cell membranes, cell components
  - Movement – muscles, movement of cells
- Amino acids - ________________ of proteins
- Consist of:
  - One carbon
  - A ________________ group (-COOH)
An _____________ group (\(-\text{NH}_2\))
- A hydrogen
- A _______________, or ______-group

- _____ different amino acids
- The _______________ determines the property of the amino acid
  - Can be large or small, hydrophobic or hydrophilic

- Amino acids are joined by __________________________
  - Two amino acids joined together are called a ____________; three are called a _________________
  - _________________ are 10+ amino acids joined together

- The ________________ of a protein is ____________ for its _______________
  - Loss of ________________ = loss of ________________
  - Proteins require a specific environment to function properly
  - _________________ (high temperature, high salt, etc …) will cause protein to ________________, or _________________

Nucleic acids
- _________________ material of organisms
  - Deoxyribonucleic acid (______) – makes up __________________________
  - Ribonucleic acid (______) – __________________________ of DNA

- The monomers of nucleic acids are _________________
  - _________________ consist of:
    - A ________________ base
    - A ________________ (5 carbon) sugar; either deoxyribose or ribose
    - A ________________ group

- Nucleotides are named after the nitrogen containing bases:
  - ____________________, ____________________ nucleotide, A
  - ____________________, ____________________ nucleotide, T
  - ____________________, ____________________ nucleotide, C
  - ____________________, ____________________ nucleotide, G
  - ____________________, ____________________ nucleotide, U

- DNA
  - Has ____________________ sugar
  - ______ nucleic acid molecules form a double helix
    - Sugar and phosphate form “backbone”
    - Bases meet in the middle
  - A always pairs with _____, C always pairs with ______
    - These bases are ____________________________ to each other
    - “__________________________”
    - _________________ bases are held together by ____________________

- RNA
  - Has ________________ sugar
  - ________________ stranded nucleic acid molecule
    - ________________ , instead of ____________________
- A to U
- C to G
  - Major role in _________________________

- Adenosine triphosphate, _______________________
  - Principal ____________________________ molecule of all cells
  - Stores chemical energy released by some ____________________________
  - Provides chemical energy for other ____________________________
  - Consists of:
    - ____________ base
    - ____________ sugar
    - ____________ groups
  - Energy is released when ____________ phosphate group is released
    - Forms adenosine ____________________________, ADP
  - ATP is created by adding ____________________________ to ADP
    - Requires ____________, usually from _________________