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 _____
  - aka, Microorganisms, germs, bugs
  - Includes bacteria, fungus, protists, algae, viruses
  - Huge diversity in _____ – only common theme is that _____
- Microbes are everywhere
  - Most famous, or infamous, microbes _____
    - _____
    - TB, AIDS, food spoilage
  - _____ are microbes that _____
  - Only _____ of microbes are _____
- Most microbes are _____
  - Directly beneficial
    - _____ (bread, yogurt, beer), make _____ in intestine
  - 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 <u>underlined</u>
- The genus is _____, species is in _____
- *Staphylococcus aureus*, *Escherichia coli*
- After the first use, scientific names may be abbreviated with the _____ and the _____:
  - *Escherichia coli* and *Staphylococcus aureus* are found in the human body
  - *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:
        - _____ – 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
  - _____
  - Multicellular _____
  - Parasitic _____ and _____ are called *helminths*
  - Microscopic stages in life cycles

Modern Developments in Microbiology

- Bacteriology
  - Study of _____
- Mycology
  - Study of _____
- Parasitology
  - Study of _____ and _____ worms
- Virology
  - Study of _____
- Immunology
  - 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 _____
  - In the 1960s, Paul Berg inserted animal DNA into bacterial DNA, and the _____
- _____, 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
  - _____ in human cells can be replaced in _____
  - 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
  - Bacteria degrade organic matter in sewage
  - 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 _____
    - Many more microbes _____.
- When a pathogen _____ the host's resistance, _____
- _____ **(EIDs)**: _____ diseases and diseases _____
    - Avian Flu
    - West Nile
    - MRSA
    - AIDS
    - 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:
    - _____
        - _____
    - _____: _____ charge, have no discernable _____
- Molecules – combination of _____ atoms
    - Sometimes called _____
- Ion – _____ atom
    - Can be _____ or _____ charged

Chemical bonds

- _____ are held together by _____ to form _____

Three kinds of chemical bonds

- Ionic bonds
  - Attraction between _____
  - _____ are _____ to each other
    - "Opposites _____"
  - Ions held together by _____, _____ interaction
    - Form an _____
- Covalent bonds
  - Bonds formed when _____
  - _____ interaction
  - Bonds can form between 2 _____ atoms, or 2 _____ atoms
  - Strongest chemical bond
- Hydrogen bonds
  - Form between:
    - A hydrogen atom covalently bonded to an _____ or _____ atom and;
    - Another _____ or _____ atom
- Order of bond strength:
  _____ > _____ > _____
- Stronger ionic bonds not biologically relevant
  - Only _____ ionic bonds are biologically important
- Covalent bonds require _____ to form, break
  - Energy can be _____ when covalent bonds _____, _____ when they are _____
- _____ bonds are biologically important
  - _____ bond, can be _____ and _____
  - Can _____ 2 molecules, or parts of the _____ molecule
  - Maintains _____ structure of many molecules

Important biological molecules

- Organic compounds always _____
- Inorganic compounds typically _____

Inorganic molecules

- _____ and structurally _____
- Typically lack _____ atoms
- Water
  - Most important _____ molecule for supporting life
    - Hydrogen bonds between _____ make it a good _____.
- _____ – a liquid with _____
- _____ – the _____

- _____ – the dissolving _____
- The ability of water to form _____ makes it an excellent solvent
  - _____ many molecules
- Dissolving molecules helps with _____
  - Atoms and molecules in solution can _____

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

Carbohydrates
- Group of organic compounds that include _____ and _____
- Important functions:
  - _____ (cell walls, DNA)
  - _____; fuel and storage
- Made up of C, H, O
- _____ are building blocks (_____) of carbohydrates
- Monosaccharides _____ sugar
  - Usually _____ in water
- Grouped by _____ in ring
  - Triose (3 C), Tetrose (4 C), Heptose (7 C)
- Disaccharides
  - Molecule of ____ monosaccharides
  - Formed from two monosaccharides by?
  - Broken into 2 monosaccharides by?
- Polysaccharides
  - Consist of _____ monosaccharides
    - Often number in the 100s
  - 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 ($-NH_2$)
    - 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 vital 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 _____
    - Order of bases is specific
    - Determines the genetic _____
- 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 _____