The Six Kingdoms – General Properties

Kingdom Eubacteria

1. Prokaryotic cell structure
    - lack extensive internal membrane systems
    - lack extensive internal compartmentalization
    - lack membrane that enclose organelles
    - DNA is not contained within a membrane-bound nucleus
2. single-celled or colonial arrangement
3. distinct ribosome structure
4. Single circular chromosome per cell; some strains have plasmid DNA
5. cell wall containing ***peptidoglycan*** (polymer found in the cell walls of prokaryotes that consists of polysaccharide and peptide chains in a strong molecular network)
6. metabolically diverse
    - **Chemotrophic vs. phototrophic metabolisms** –
        - oxidation of chemical compounds they "eat"
        - light energy to carry out photosynthesis
            1. photosynthetic pigments and reaction centers in plasma membranes.
            2. aquatic photosynthetic bacteria have adapted to use wavelengths of light other than used by the plants and green algae that grow near the water's surface
    - **Organotrophic vs. lithotrophic metabolisms**
        - use reduced organic compounds (carbohydrates and lipids
        - lithotrophs, organisms that can use reduced inorganic compounds
            1. sulfide
            2. elemental sulfur
            3. ammonium, nitrite
            4. others
    - **Heterotrophic vs. autotrophic metabolisms**
        - Heterotrophs – use organic carbon (carbohydrates, lipids, and proteins
        - Autotrophs - use carbon dioxide as their sole carbon source.
    - **Oxidative vs. fermentative metabolisms**
        - Some heterotrophic bacteria metabolize nutrients exclusively through pathways of oxidative metabolism, or respiration
        - Most oxidative bacteria use oxygen as a final electron acceptor (but some can use other acceptors as well such as sulfate or nitrate)
        - Many of the heterotrophic bacteria have fermentation pathways that allow them to continue growing under conditions of reduced oxygen
7. widely distributed, occupying diverse ecological niches

The Six Kingdoms – General Properties

Kingdom Archaea

1. Prokaryotic cell structure
   - lack extensive internal membrane systems
   - lack extensive internal compartmentalization
   - lack membrane enclosed organelles
   - DNA is not contained within a membrane-bound nucleus
2. single-celled or colonial arrangement
3. distinct ribosome structure
4. cell walls are composed of different polysaccharides and proteins, with no peptidoglycan; many have cell walls made of the polysaccharide pseudomurein
5. unusual metabolisms and live in extreme environmental conditions
   - ***chemolithotrophic*** metabolisms
     - obtaining energy from the oxidation of inorganic materials such as sulfur or hydrogen sulfide
     - one group, the methanogens, are noted for their ability to produce methane
   - inhabit some of the most seemingly ***inhospitable habitats*** on earth.
     - ***hyperthermophiles*** live in hot springs at temperatures above 70°C
     - extreme ***halophiles*** live in highly saline environments, such as the Dead Sea and the Great Salt Lake, under conditions of osmotic stress that would kill most cells
     - extreme ***acidophilic***, and others are extremely ***alkalophilic***, living in conditions of extreme pH

The Six Kingdoms – General Properties

Kingdom Protista

1. eukaryotic cell structure
   - exhibit extensive internal membrane systems
   - exhibit extensive internal compartmentalization
   - have membrane enclosed organelles
   - DNA is contained within a membrane-bound nucleus
2. single-celled or colonial arrangement with no true tissue-level organization
3. distinct ribosome structure
4. diverse phylogenetic groups

    - **Protozoa**
        - animal-like cells - plasma membrane called a pellicle
        - **most** are chemoheterotrophic metabolism - obtain their energy and carbon by the breakdown of organic carbon sources
        - **few** are photosynthetic, having chloroplasts
        - **most** are single-celled organisms - grouped primarily on their mechanisms of motility
    - **Algae**
        - plant-like cells - cellulose-based cell walls and chloroplasts
        - classified into different groups on the types of photosynthetic pigments
        - range in size from single-celled organisms to large multicellular structures (no true tissue-level organization
    - **Slime molds and water molds**
        - None are photosynthetic.
        - Morphological forms
            1. single cells
            2. filament-like chains of cells
            3. cellular aggregates
            4. coenocytia - single cells containing many nuclei, all surrounded by a single plasma membrane
            5. some can exist in more than one form at different stages in their life.
5. widely distributed, displaying great metabolic and ecological diversity
    - aquatic and soil microorganisms
    - heterotrophic and phototrophic metabolisms
    - break down dead and decaying organic matter
    - predators - capturing and consuming other protists and bacteria
    - pathogenic - parasitic relationship with another species

The Six Kingdoms – General Properties

Kingdom Plantae

1. eukaryotic cell structure
2. multicellular
3. use energy from sunlight to produce carbohydrates via the process of photosynthesis
    - contain chlorophyll a and b,
    - unable to move by means of contracting fibers (eg. muscles in animals)
    - bodies made up of cells which are differentiated to form tissues and organs
    - develop from embryos that are protected and nourished for a time by tissues of the parental plant.

4. The multi-cellular algae share some but not all of these characteristics with plants. The ancestors of plants are believed to have been one or more ancient species of multi-cellular green algae.

5. The overall trend in the evolution of plants has been towards:
    - life cycles dominated by the diploid form
    - plants that bear seeds
    - non-motile gametes moved by wind, or insects, NOT water (free water no longer required for fertilization;
    - presence of vascular tissue (**none of the algae show this characteristic**)

The Six Kingdoms – General Properties

Kingdom Fungi

1. eukaryotic cell structure
2. cell walls containing cellulose and chitin
3. single-celled or with cells arranged in filaments called hyphae
    - single-celled fungi are called **yeasts**
    - "multinuclear" might be more appropriate than "multicellular" because, in many cases, there is no actual separation between the nuclei in the hyphae.
    - fungal hyphae can be divided into two main groups, based on the amount of separation that exists between their nuclei:
        - **Non-septate hyphae (coenocytial hyphae)**
            1. nuclei inside the filament are not separated by cell walls
            2. as the hyphae grows and gets longer, the nuclei reproduce by mitosis, but there is no cytokinesis nor cell wall formation between the new nuclei
        - **Septate hyphae**
            1. nuclei are separated by cell walls
            2. when a nucleus divides by mitosis, a cell wall partition or septum forms between the new nuclei.
            3. separation is not complete - there are pores in the septa that allow movement of cytoplasm between the cells.
    - random tangled masses called mycelia (singular: mycelium)
        - **molds** - mycelia often spread to fill the available space, limited by available nutrients.
        - **fleshy fungi** - mycelia that are structured into well-defined forms or morphologies, such as in mushrooms. Even in mushrooms, there is very little tissue-level differentiation.
        - **dimorphic fungi**
            1. can exist as either yeasts or hyphae depending on the environmental growth conditions
            2. several important pathogenic species
4. chemoheterotrophic metabolisms, obtaining nutrients through chemical absorption
5. widely distributed, acting as decomposers or as parasites

The Six Kingdoms – General Properties

Kingdom Animalia

A "common thread" literally holds the animal world together. The thread is a group of compounds known as the extracellular matrix (ECM for short).

1. glue holding cells together in the organ systems found in many
2. network that allows cells to move from place to place during the course of embyronic development
3. composed of four distinct types of fibers
    - collagens
    - proteoglycans
    - adhesive glycoproteins
    - integrin.
    - slight variations in the structure of these compounds among the members of the animal kingdom
    - basic similarity across all members of the kingdom
4. This fact and the lack of an ECM in other kingdoms indicates that despite the diversity of body shapes, sizes, and structures we find in the Animalia, all its members likely share a common ancestor.